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Photo: W. R. B. Battle

Fig. 1. Cavern at icefall in glacier to the southwest of Base Camp. Ice flows from right to left.

BAFFIN ISLAND EXPEDITION, 1953: A PRELIMINARY FIELD REPORT

P. D. Baird* and other members of the expedition

The Arctic Institute's second Baffin Island expedition, organized from the Montreal office, was in the field in the Cumberland Peninsula area from May until September of 1953. The expedition was on similar lines, but a smaller scale than that of 1950 to the Clyde district (*Arctic*, Vol. 3, pp. 113–49). The major financial support came from the Institute itself through the Banting Fund, the United States government, and the McGill University–Arctic Institute Carnegie program which assisted three expedition members. As before the Swiss Foundation for Alpine Research gave generous help and selected a strong team of four Swiss scientist-mountaineers. Other welcome contributions came from the Canadian Geographical Society and several private subscribers in Montreal.

The party was composed as follows:

P. D. Baird	Leader and Glaciologist	Arctic Institute
W. R. B. Battle	Geomorphologist	McGill University
B. H. Bonnlander	General Assistant	McGill University
D. J. Kidd	Geologist	Toronto
J. Marmet	Physiologist and Surveyor	Switzerland
S. Orvig	Meteorologist	Arctic Institute
H. Röthlisberger	Geophysicist	Switzerland
F. H. Schwarzenbach	Botanist	Switzerland
H. R. Thompson	Geomorphologist	McGill University
J. A. Thomson	Photographer	McGill University
W. H. Ward	Glaciologist	England
A. Watson	Zoologist	McGill University
J. R. Weber	Geophysicist and Photographer	Switzerland

Cumberland Peninsula was first visited by John Davis in 1585 and some of the names he gave to features still appear on the map. Nearly three hundred years elapsed before any white explorer penetrated its interior though the coasts became known to whalers, especially to Captain Penny who "rediscovered" Hogarth Sound (Cumberland Sound). Boas, the German anthropologist, spent the year 1883–4 in the area. He crossed Kingnait Pass, made a remarkably accurate map mainly from native report, and named the ice-covered mountain region to the west of Pangnirtung Pass the Penny Highland.

After the Hudson's Bay Company and R.C.M.P. posts were established at Pangnirtung in the early 1920's, winter patrols went through Pangnirtung Pass gaining a healthy respect for its difficulties as a sledge route. So did J. Dewey Soper in 1924 who gave the first detailed description of the route. Parties of

*Director, Montreal Office, Arctic Institute.

the Geological Survey of Canada, under Weeks 1926–7 and Riley 1951, examined the Cumberland Sound coast but the interior was largely a scientific blank.

Our expedition had the 1948 and 1949 air photographs available for study, but our knowledge of the altitude was based on the estimate of 8,000–8,500 feet for the Penny Icecap and several 7,000-foot spot heights for mountains, together with Soper's report of a 1,200-foot altitude for the summit of the pass.

In 1950 many of the most valuable results of the Institute's expedition were those in the field of glaciology, and as this subject had been given an important place in the general research aims of the Institute it seemed a logical step to explore the other large ice area of Baffin Island which was known to be higher and believed to lie in an area of greater precipitation than that of the Barnes Icecap near Clyde Inlet.

We planned to determine whether a firn area existed on the summit of the Penny Icecap and to examine the glacial regime there and at various points on a representative outflowing glacier. For logistic reasons Highway Glacier leading to the centre of Pangnirtung Pass was selected. Studies of the thickness and movement-rate of the ice were planned for this glacier. A geomorphological investigation of the whole pass area, where results of existing as well as past glacial processes could be seen together, was to be undertaken, as were studies on bergschrunds. The geology, botany, and zoology of the district were to be investigated according to the special interests of the scientists concerned.

Thirteen tons of expedition stores had been sent to Pangnirtung settlement by sea in 1952. Owing to the tragic loss of the Institute's Norseman aircraft in 1951, it was not possible to have the luxury of an aircraft available throughout the season but a Norseman, chartered from Arctic Wings of Churchill, was used to establish the expedition in the field after the party and 4,000 lbs. of equipment had been kindly flown to Frobisher Bay by the Royal Canadian Air Force on May 12. The latter also assisted the expedition towards the end of the season when a Canso of 408 Photo Survey Sqn. engaged in local Shoran operations, picked up the party of four men who had evacuated our ice-cap station by a 28-mile sledge trip to tidewater, transferred them to the Base Camp, and then took much heavy equipment from there out to the settlement at Pangnirtung.

The Norseman aircraft flew about 65 hours for the expedition; 30 of which were on the flight to and from its base at Churchill, 15 ferrying the party in 4 loads from Frobisher to Pangnirtung, and 20 establishing the field camps and moving personnel out of Pangnirtung. Its local operations were all over on May 26, and it was away from Churchill only three weeks.

Main expedition camps were the Base Camp at Summit Lake in the centre of the Pangnirtung Pass at 1,300 feet, A1 on the ice cap at 6,725 feet, and A2 at the head of Highway Glacier at 6,300 feet; the latter was later moved to A3 at 3,400 feet and subsequently all the way down the glacier to the Base Camp. The Biological Camp in Owl valley (600 feet) was established in June from a lakeside cache 1,800 feet above it, the nearest point where our

Photo: W. R. B. Battle

Fig. 2. Base Camp at the end of May.

Fig. 3. Bonnlander carrying ration box (14-man-day) from aircraft landing place to Base Camp, about 1,000 yards. Arrows indicate mountain called "The Queen".

Photo: W. R. B. Battle

aircraft could land. A mountain cache was also put down (Camp M on the map) at 4,500 feet. These last two were established on our last flying day, in difficult cloud and snow surface conditions.

From then on the party was on its own; foot, ski, and manhauled sleds were the means of transportation between camps. The main routes travelled were the full length of Pangnirtung Pass, Highway Glacier from the pass to the ice cap, and June River to Padle Fiord. An initial dog-team trip in the Padloping area gave Watson and Kidd a chance to examine the birds and rocks of that region, the latter returning there by Kingnait Pass to make a closer examination of the geology in August.

The camps were evacuated in August; the ice cap on August 10 and the Base Camp on the 27th. The personnel sailed from Pangnirtung aboard the C.G.S. *C. D. Howe* on September 7, arriving Montreal September 13.

One member of the party did not return. Ben Battle, Senior Fellow in the McGill University–Arctic Institute Carnegie program, was accidentally drowned on July 13 near the Base Camp. He was buried on the moraine overlooking the finest part of the pass in the area in which he had last worked with such enthusiasm.

The map (Fig. 4) shows the main camps and the routes travelled by the expedition. The following sections describe the various scientific investigations.

Glacier physics. By W. H. Ward

The Penny Icecap extends northwestwards from Pangnirtung Pass for some 90 miles, and is about 20 miles wide. It is bounded on the northeast and southwest sides by two remarkable straight valleys partly filled with tributary glaciers coming from the ice cap and partly with ice-dammed lakes. It is comparable in area with the Barnes Icecap, which was visited in 1950, but in other respects is quite different. The ice generally appears to be a few hundred feet thick and its surface takes the form of domes fused together by broad valleys which spill relatively thick ice into more than a dozen major valley glaciers. The outer domes frequently terminate in ice cliffs only 100 to 200 feet high above 3,000-foot-high rock walls that form the valley glacier troughs. On the north and east sides three glaciers reach sea level in the heads of fiords. One of them, Coronation Glacier, is 2 miles wide and over 20 miles long.

The highest ice-cap dome at 6,725 feet, where Svenn Orvig and the writer established Camp A1 on May 16, lies near the southeast end of the ice cap and from here the general level of the ice decreases towards the northwest to an elevation of about 2,000 feet. Southwards from the southeast end of the ice cap lies the 10-mile-long Highway Glacier, one of three glaciers that flow into the head of Pangnirtung Pass. This glacier was used as a ski route between the Base Camp and Camp A1. Studies in glacier physics were concentrated at Camp A1 and at numerous sites between there and the Base Camp along this route.

Some of the observations made at these sites between elevations of 6,725 and 1,430 feet are listed briefly below, together with the results.

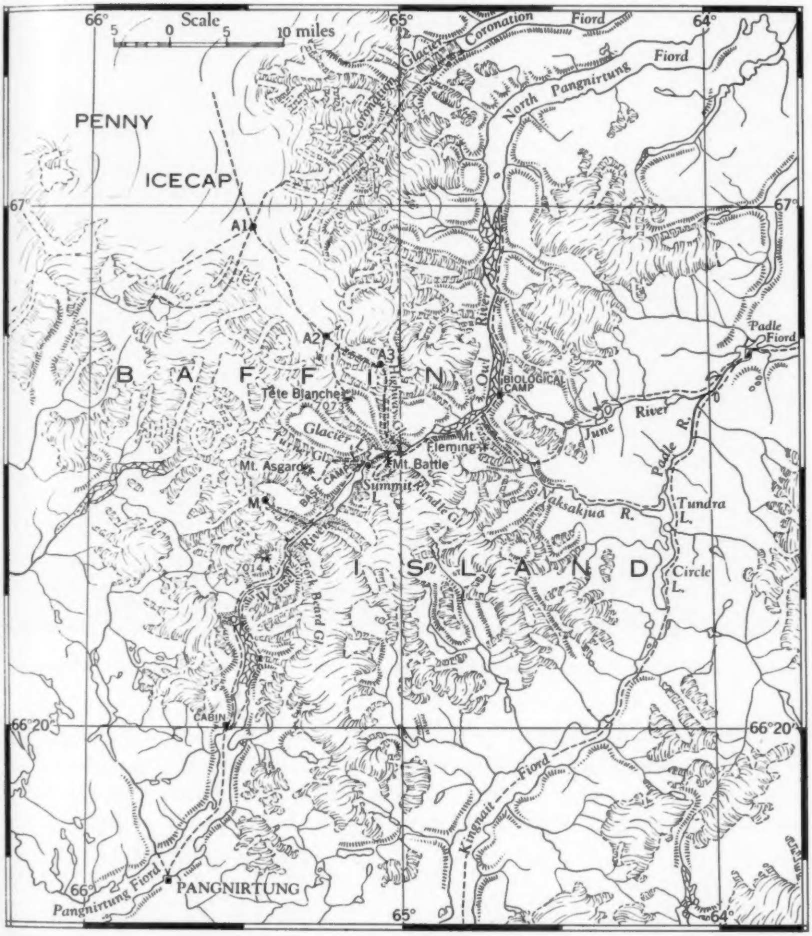


Fig. 4.

Accumulation and ablation

The accumulation and ablation of snow and ice were observed relative to a dozen bamboo stakes drilled into position. In the vicinity of these stakes 38 pits were excavated at frequent time intervals to measure the density, temperature, and structure of the deposition and to follow the progress of accumulation and ablation in quantity. The current annual snow attained a maximum thickness of between about 32 and 42 inches (10 to 15 inches of water). There was no significant increase with altitude and a few values greater than that quoted above could be attributed to local drifting. Much of the snow that fell during May, June, and July at 6,725 feet was blown

Photo: W. H. Ward

Fig. 5. Highway Glacier from summit of Mt. Battle. Arrows indicate position of Camp A3.

away the day after it fell. Rime and hoar frost deposits on all upstanding objects were considerable and very frequent at this altitude, but the amount that formed on the snow surface was relatively small. The firn melted away up to an elevation of about 5,000 feet, that is approximately at the level of the head of most of the outflowing glaciers. Superimposed ice formed directly from meltwater reached a maximum thickness of about 3 inches over the old ice surface of the glaciers, but the total area of superimposed ice remaining in August was quite small on account of the steepness of the glacier surface just below the firn.

Melting of the snow started in mid-May at 1,430 feet and all the snow and over 7 feet of original ice was lost from lower Highway Glacier by the end of August.

At 3,340 feet, only 27 inches of original ice was lost, together with the current snow. Melting started here on June 23 and lasting snow returned about August 16.

At 6,725 feet, on the summit of the ice cap, surface melting was not continuous for more than about 60 hours. A melt of that duration commenced on July 13, another of 30 hours started on July 19 and one of 60 hours began on July 23. Thereafter, until August 10, when this camp was evacuated, another 40 hours of surface melting occurred in short periods lasting a few hours. The firn did not melt to a depth greater than about 5 feet, and was

Photo: W. H. Ward

Fig. 6. Main tent at Camp A1 with hoar frost on guy-ropes. Kew Robitzsch actinograph in foreground.

refreezing downwards from the surface and upwards from below for several days before we left. The total amount of melting is provisionally estimated to be about 4 inches of water.

Thermal measurements

Ice temperatures were observed to a depth of 32 feet at elevations of 3,340 and 1,430 feet and to a depth of 70 feet in the dense firn at 6,725 feet. The steady temperatures below the zone of seasonal change are about -13.3, -5.8, and -5.5°C at altitudes of 6,725, 3,340, and 1,430 feet respectively.

A heat-meter plate pushed into the snow from the side of a shallow pit was used to measure the heat flow through the snow during the period before melting commenced at 6,725 feet.

Radiation measurements

Continuous recordings were made of the incoming short-wave radiation on the new Kew type Robitzsch instrument at 6,725 feet. The maximum intensity amounted to about 1 cal./cm.^{2}/min. on a clear day, and at midsummer the total daily radiation was about 780 cal./cm.^{2} (Latitude 66°58½N.).

Observations of the net radiative flux into or out from the snow surface were made with a Gier and Dunkle type blown-plate radiometer constructed by the writer, which uses thermistors for the sensitive elements. Measurements of both incoming and outgoing short-wave radiation were made with

two other specially constructed radiometers employing thermistor elements. The observations enable the long- and short-wave components of the incoming and outgoing radiation to be evaluated, and will be used in a study of the heat exchange at the snow surface.

Glacier movements

Measurements were made by theodolite triangulation of the absolute movement of 8 points on the surface of the mile-wide Highway Glacier at an elevation of about 2,500 feet, where the surface slope is about 3 degrees. The points formed two transverse lines over ½ mile apart down the glacier. There were 4 points on each transverse line; they were observed on July 7 and 38 days later. The horizontal movement of the points parallel to the general longitudinal axis of the glacier varied irregularly from 10 to 52 feet. The largest movement occurred near one rocky boundary in the most crevassed zone and where there was also a considerable transverse movement towards the boundary. On the other side of the glacier the longitudinal (and horizontal) movements were more uniform and averaged about 20 feet. Here it was found, by comparison with an air photograph taken in 1948, that a lateral moraine of limited length and travelling at the same speed as the ice had moved about 1,000 feet in 5 years. This rate of strain compares well with the short-term measurement. The rate at which crevasses adjacent to the steep rock walls visibly opened and closed around one of our tents on the glacier confirms the rather high rates of strain in the glacier. These observations are to be used in conjunction with the seismic depth soundings carried out by Röthlisberger to analyse the mechanics of the glacier flow.

The writer was ably assisted in maintaining continuity in the observations at the various sites by Baird, Orvig, and Bonnlander. All the figures quoted in this report are preliminary only and may be subject to correction later.

Seismic sounding. By H. Röthlisberger

The seismic work was carried out in two different locations, first in the flat firn area around Camp A2, on the southeastern edge of the ice cap, and secondly on Highway Glacier between Camp A3 and the tongue of this typical valley glacier. A2 was chosen as it was a good landing place for the Norseman aircraft, and we could reach Highway Glacier without being troubled by crevasses or very steep hillsides.

The equipment, donated by the Magnolia Petroleum Company, consisted of 6 geophones (plus 4 spares), 6 amplifiers with high level and low level output, a 16-channel recording camera (12 of the galvanometers connected to the amplifier outputs, one recording the time break, leaving 3 in reserve), and the blasting equipment with telephones. To cut down weight we used four motorcycle batteries, charged by a very light 400-watt generator (DKW type GG 400), for power supply instead of a car battery. Since most of the equipment had been used before on trucks for oilfield work, the whole equipment was rather heavy, the packed total being 700 lbs. The surveying was done with a theodolite T 0 lent by Wild of Heerbrugg.

Photo: J. A. Thomson

Fig. 7. Weber with the geophones.

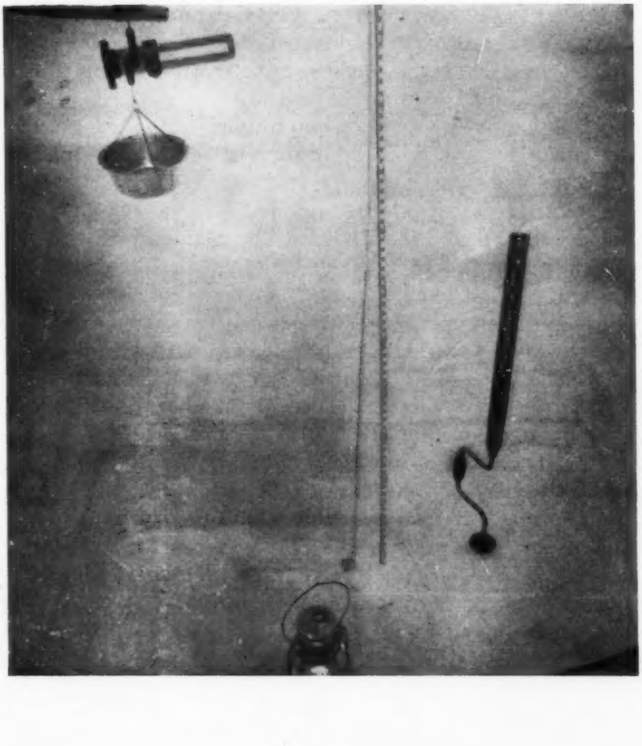


Fig. 8. The pit at Camp A1 after 10 feet of digging was continued to 70 feet with device connected to brace.

Photo: W. H. Ward

On May 20 Weber and the writer set up camp at A2. We started the seismic work on May 27 after the other two members of our Swiss team had arrived, and carried on, mainly in bad weather with temperatures around 5°F, but not too strong winds, until June 5. During the next five days the four of us moved some 2,500 lbs. of food, camping material, and seismic equipment down to A3. One hundred and seventy pounds were carried as backpacks, 1,500 lbs. in 5 trips on a Gaillard-Dufor ski-improvized sled, 500 lbs. in one trip on a magnesium sled similar to a small Nansen sled in design, and 300 lbs. on one of the Canadian Army "pulkas", also in one trip. In the deep fresh snow on the plateau none of the three sleds ran well, but farther down we were lucky to have suitable conditions for each sled: the ski-improvized sled ran best in light snow below freezing; the magnesium sled better above freezing or on a solid crust, and the pulka well on a smooth ice crust only. Later in the season the magnesium sled worked extremely well on bare ice and proved remarkably strong.

From June 11 to July 6 we stayed at A3 and worked from three different centres on Highway Glacier, the total length of shooting profiles being 8 to 9 miles. Towards the end of this period we were working in the full-melting season, the conditions for walking and transportation became atrocious, and we lost some 1,000 feet of telephone cable by the sudden outbreak of a meltstream. On July 7 we moved the seismic equipment to a safe place on a medial moraine about 2 miles farther down the glacier, and left for mountaineering. The seismic work was taken up again from July 29 to August 9 on the lower parts of Highway Glacier. The more precious parts of the equipment were then brought over to the Base Camp to be flown out by the R.C.A.F. Canso. Altogether the seismic work took some 140 man-days, working mostly in groups of two to four men. The greater part of the work was done by the Swiss, though we were helped considerably by J. A. Thomson and occasionally by others.

Most of the shooting was done by laying the charges on the surface of the ice rather than drilling holes. The charges had to be 5 to 10 times bigger, but the records were as good. We had dynamite to spare, time was more precious. Three hundred pounds of 60 per cent high velocity gelatin (Forcite), which had been stored at Clyde since 1949, were picked up by our Norseman aircraft. For drilled charges we used 40 per cent Forcite in small cartridges of which 50 lbs. were brought with us from Montreal. The dynamite and the blasting caps were donated by Canadian Industries Limited. For an accurate determination of the seismic velocities in firn and ice we had a few special seismocaps, but for most of the work short-period ordinary caps proved sufficient. The surface charges ranged from half a pound to 3 lbs. for distances of ¼ to ¾ of a mile between blast and geophones. The geophones were laid in two parallel lines of three each, with the same distance of 200 feet between the lines and between each geophone in the line. All the shooting was then done on profiles lining through two or three geophones. This set-up made it possible to obtain the position and slope of the reflecting rock surface fairly accurately by combining groups of three geophones in a triangle for

calculation or geometrical construction. Around 200 records were obtained in the whole period, the greater part showing good reflections. The best records were obtained on Highway Glacier when the ice was covered by one to two feet of snow.

At A2 on the firn plateau no reflections could be recorded; but by the refraction method the total thickness of firn and ice was found to be of the order of 700 feet, the top layer (of looser structure than the main ice body) being some 100 feet thick. The profiles across Highway Glacier showed a rather flat valley bottom with the deepest channel to the west. The thickness of the glacier reached as much as 1,300 feet where the main branches met, and decreased steadily to 450 feet above the steep drop down to the main valley of Pangnirtung Pass. The tongue seemed to be thicker again, but no reflections could be obtained there. A long refraction profile was laid along the tongue which showed the bedrock to be from 500 to 700 feet below the ice surface.

Meteorology. By Svenn Orvig and B. H. Bonnlander

Ice cap station

The ice cap meteorological station was established at Camp A1 on May 16, at 66°58½N., 65°28W., on the highest dome, 6,725 feet above sea level. From May 21 to August 9 the following observations were made every two hours, from 0800 to 2000 daily: pressure (by aneroid and barograph); temperature at 3, 13, and 23 feet above the surface; humidity at 3 feet (by aspirated hygrometer and hygrograph); wind speed and direction at 6 feet; also cloud, fog, visibility, and ceiling. At 0800, 1400, and 2000 hours maximum and minimum temperature and precipitation were measured, and thermograph records were kept for 81 days. Sunshine was recorded by a Campbell-Stokes recorder. Air temperatures at 13 and 23 feet were measured by thermistors, otherwise standard meteorological instruments were used.

Little is known about the climate of the ablation period on Canadian glaciers and ice caps; the problem was studied on the Barnes Icecap in 1950, and it was logical to use identical methods on the Penny Icecap as far as was possible. In systematic investigations of glaciers, glaciological and meteorological studies are complementary, and to evaluate the dependence of ablation on the various meteorological factors a knowledge of the radiation conditions is essential. The expedition was well equipped to undertake radiation measurements, with an M.S.C. Type G Bimetal Actinograph lent by the Meteorological Division, Department of Transport, an actinograph made at Kew Observatory, as well as a net radiation fluxmeter and two radiometers. Both actinographs will be recalibrated before final conclusions can be reached, but from preliminary figures the Canadian instrument gave readings 20 per cent higher than the Kew instrument. The amount of radiation recorded on the M.S.C. actinograph varied within fairly wide limits, averaging from 0.3 to 0.8 cal./cm.^{2}/min.

The total hours of sunshine recorded in June and July were less than that on the Barnes Icecap in 1950 (168 and 143 hours, compared with 207 and 153). Comparison of radiation is difficult because fog on the Penny Icecap was

frequently thick enough to stop the Campbell-Stokes instrument from recording, but not to prevent short wave radiation from reaching the surface. At 6,725 feet, surface and adiabatic cooling of moist, maritime polar air caused fog on 25 days in June, 27 in July, and 8 of the first 9 days in August.

The frequent high relative humidity on the Penny Icecap also affected the moisture gradient above the snow surface, and hence the evaporation. On the Barnes Icecap there was an almost permanent gradient in all but foggy weather, the air at higher levels being warmer and drier than the surface layer. It appears that the total evaporation on the Penny Icecap must have been small.

Ablation, at least in the higher parts of the ice cap, was mainly due to melting caused by radiation, in spite of the low surface temperatures. Convection was not important, since during the whole "summer season" there were only 14 days with maximum temperatures above 32°F. The absolute maximum of 38.5°F was recorded on July 25. Ablation took place in a few interrupted periods, counted in hours, unlike the continuous ablation period of 52 days on the Barnes Icecap.

Accurate measurements of precipitation are always difficult in the Arctic. On the Penny Icecap the problem was further complicated by frequent deposition of hoar frost directly on the surface, which proved to be almost impossible to measure. Drifting snow caused much trouble, as expected. A wind of about 13 m.p.h. would start surface drifting, and as snowfall usually occurred with relatively strong winds, the following figures for snowfall are possibly a little too high. Three inches of snow fell during the last 11 days of May, June had 13 inches, and July had 16 inches of snow and just under 1 inch of rain.

Wind speeds on the ice cap were surprisingly low. The maximum recorded was 36 m.p.h. on May 28 with a mean temperature of –9.4°F. From previous experience we had expected a number of low pressure frontal systems to pass over the area, bringing strong winds. In fact, blizzard conditions occurred on only 9 days out of 85, compared with 18 on the Barnes Icecap in 1950. S.O.

Base Camp station

Continuous weather observations were taken at the Base Camp in Pangnirtung Pass from May 17 to August 27, a total of 103 days. This was possible thanks to the combined efforts of six members of the expedition. The following observations were made daily: pressure by aneroid and barograph trace; temperature, both maximum and minimum, dry and wet bulb, and thermograph trace; precipitation; cloudiness; and wind, both direction and strength, the latter measured by hand-held anemometer. A hygrograph was also kept in operation throughout the summer.

In comparing the data with the records from Pangnirtung the general picture is that of an average season. The weather appears to have been largely controlled by an interplay of two factors: the high and low pressure systems passing over southern Baffin Island, and the local influence of cool, moist,

Photo: J. Marmet

Fig. 9. First camp on descent of Coronation Glacier from Camp A1 (on far dome behind tent).

Fig. 10. Orvig, Bonnlander, and Marmet evacuating Camp A1 down Coronation Glacier.

Photo: W. H. Ward

maritime polar air coming up from the fiords at each end of the pass, which produced a particularly unpleasant, misty "base camp weather". Because of the exposed location of the camp at the head of the pass, and the funnelling action of the valley, there was rarely a lull in the steady, but not strong, northeast and southwest winds that came in almost equal frequency. Each month had a period of fine and of bad weather, but otherwise the pattern changed almost daily.

The camp was established during a week of warm and sunny weather accompanied by rapid melting of the snow. During the last four days of May, however, temperatures dropped to the low twenties, with snow and winds that blew steadily between 20 and 30 m.p.h.

The first three weeks of June were cold, moist, and almost without sunshine, with frost every night and a maximum temperature of 40°F reached only on the 16th. The final week at last brought sunny, warm days and mild nights.

Throughout the first half of July the weather was warm and settled and the first heavy rain fell. Cool, moist, and rainy weather persisted for the last ten days, during which time the thick ice on Summit and Glacier lakes finally broke up and disappeared.

August was as mild and rainy as July. The first and heaviest snowfall came on the 16th, and terminated the mosquito season. The final week provided the evacuating party with the best weather of the summer, with daytime temperatures in the upper fifties and cool, almost windless, nights.

B.H.B.

Geology. By D. J. Kidd

Four geological traverses were planned for the summer: (1) by dog team for ten days on the shore ice in the Padloping area at the end of May; (2) overland from Padle Fiord for 25 miles up June River valley to its junction with the remarkable Pangnirtung Pass; (3) across Cumberland Peninsula in June and July along the full 60-mile length of the pass on foot and down Pangnirtung Fiord by schooner; and (4) by R.C.M.P. Peterhead boat along the coast from Pangnirtung to Padloping and return, thereby completing the circuit of the peninsula by the end of August.

The first three traverses were completed as planned. Ice movement at Cape Mercy unfortunately forced the R.C.M.P. vessel to return to Pangnirtung, and Padloping was finally reached by walking over Kingnait Pass, a distance of 40 miles to Padle Fiord, in two days. Nearly two weeks were then spent on foot and by whaleboat in the Padloping area.

The last four weeks were passed on the C.G.S. *C. D. Howe* and C.G.S. *d'Iberville* visiting all the Eastern Arctic ports north of Padloping. On the return trip south on the *d'Iberville*, the coast was examined through binoculars from Cape Searle to Cape Dyer and as far as Exeter Sound. This left a gap of nearly 140 airline miles along the eastern end of Cumberland Peninsula which was not mapped. The writer would like to close this gap in the near future.

Precambrian-type rocks

The majority of rock exposures seen in the Cumberland Peninsula were of Precambrian-type granites, granite gneisses, and quartz-biotite paragneisses with occasional conformable bands of amphibolite and biotite paraschists. The granites are ovoidal, myrmeckitic, and "normal". The more basic varieties possibly contain hypersthene or hastingsitic hornblende and thus could be granulites or charnockites. The ovoidal granites are associated with phenomena of granitization, and resemble in texture the Rapakivi granites of Fennoscandia and southern Greenland. The myrmeckitic granites, which occur in areas of minor folds, are devoid of the dark fragments of argillaceous material found in the ovoidal granites. The pegmatites and aplites, both conformal and cross-cutting, are without mineralogical interest. They are absent in large masses of the ovoidal granites but very common in adjoining bands of augen-gneisses, quartz-biotite paragneisses, and amphibolite, and are cut by gabbro or diorite dykes.

Except for rare occurrences of specularite in epidotized granite gneiss, no economic minerals were found in Precambrian rocks. The sole interest of biotite paraschists, weathering rusty by oxidation of pyrites, appears to be their use as local horizon markers. Amphibolite bands are also useful for mapping purposes in Pangnirtung and Kingnait passes.

Tertiary-type rocks

There has been considerable speculation on whether the "belt" of Tertiary volcanic rocks, which extends from Scotland, through Iceland to eastern and western Greenland, can also be found in Baffin Island. McMillan's observations[1] in the region of Durban Harbour suggested that volcanic rocks were to be found in that area.

This past summer erosional remnants of flat-lying Tertiary-type basalt flows were found to occur for 55 miles along the Davis Strait coast from Cape Searle island to Cape Dyer. They seem to extend no more than five miles inland and are separated by fiords and embayments. These flows contain the alternate grey and red members typical of plateau basalts and their lower limits appear from the sea to be uniform in altitude, generally between 1,100 to 1,800 feet above sea level. Some of the basalt tops east of Durban Island may be slightly over 3,000 feet high. The top of the highest basalt flow on Padloping Island is about 2,800 feet.

Near the northeast end of Padloping Island, these basalt flows, which are apparently of subaqueous origin, rest on a series of alternating beds of rusty crossbedded agglomerates, or "submarine breccias" of amygdaloidal basalts, and dense battleship-grey flat-lying beds either of lava or of tuffaceous material. The contact between these rocks is about 1,450 feet above sea level. No ellipsoidal lavas were seen. Cape Searle itself, and the northern neck of Cape Searle island are composed entirely of the crossbedded agglomerates and grey tuffaceous material. Red and grey flat-lying basalt flows were seen only on the top of the highest hill in the centre of Cape Searle island, where about two

[1]McMillan, J. G. 1910. "Report" in Bernier, J. E., 'Cruise of the Arctic', pp. 423–4.

hundred feet of basalts rested unconformably on biotite paragneiss and granite gneiss formations. The top of the hill was estimated to be about 1,200 feet high, while the crossbedded agglomerates composing the string of Gothic towers, interconnected by short incredibly-pinnacled ridges of the rocks, are about 800 feet above sea level.

It would appear, then, that the volcanic activity was episodic and that submarine accumulation of agglomeratic beds took place on a shelf area between Cape Searle and Padloping Island. Another possible explanation would be that this shallow channel may have been the site of an ancient river delta consisting of sedimented volcanic ejectamenta. However, the crossbedded agglomerate bands at Cape Searle dip southerly while those in the Padloping massif seem to dip to the north. This suggests that these beds formed the lower slopes of separate volcanic vents. However, the original plateau-like character of the basalt flows would perhaps presuppose that the lavas came not from circular vents but from fissures.

Castellations and pinnacles of dark brown rocks similar to those on the north end of Cape Searle island were seen on a promontory about five miles southeast of Reid Bay. It is possible that they are composed of the same banded agglomerates; no crossbedding could be seen however. The flat dome of the hill behind the promontory seemed definitely to be composed of the red and grey flat-lying basalt flows. Observations at the time were greatly hindered by fog and a choppy sea.

Semi-consolidated beds of sandstone with intercalated shales occur at sea level, in strips a few hundred feet long and 20 to 30 feet or more in width at the foot of the banded-agglomerate massif near the northeast end of Padloping Island and a small strip was seen at the base of the mainland opposite Durban Island. The contacts were obscured at both localities by heavy scree cover. It is possible that the sandstone beds abut against the base of the crossbedded agglomerate at Padloping and are younger than the Tertiary-type basalts.

The sandstones contain several seamlets of soft, occasionally dense, lignitic to sub-bituminous coal up to 10 inches thick and averaging 3 or 4 inches. At the Padloping locality there was also a seam up to 35 inches thick of very crumbly or flaky lignite mixed with considerable sand from the overlying friable sandstone. The sandstones and interlying members at Padloping dip six degrees westerly. Those near Durban Harbour appear to be horizontal. It is possible that some of the lignite has been raised to sub-bituminous rank by local vulcanism; in that case, the sediments would either be intervolcanic or older than the lavas. It is hoped that it may be possible to have carbon-isotope tests made on the woody varieties of the lignite to determine the probable age of the sediments.

Vertical to subvertical dykes of gabbroic material, sometimes with an ophitic (diabasic) texture, finger out upwards from the sea into the agglomeratic and tuffaceous beds, but apparently do not cut the flat-lying basalt flows. These dykes and the dykes cutting the Precambrian-type rocks in the Padle Fiord area may be associated with the source of the vulcanism.

Structure

The Precambrian-type rocks are folded largely northwesterly parallel to the Davis Strait coast, but variations in the regional trend were noted in the Padle Fiord area, June River valley, and the central third of Pangnirtung Pass, where the gneisses and schists strike generally north of east. The structure in Pangnirtung Pass is difficult to determine, because of the predominance of ovoidal and myrmeckitic granites, but the gneisses and schists wherever observed generally vary in strike between northwest–southeast and north–south around North Pangnirtung Fiord and southwest of Summit Lake.

The intensity of folding seemed to increase southwestward from gentle to moderate in the Padloping area to isoclinal at the head of Pangnirtung Fiord, and becomes moderate again south to the Cumberland Sound coast. Minor folds, with axial planes haphazardly oriented, were observed in the June River and central Owl River valleys.

At least three sets of joints may be recognized in the Cumberland Peninsula area. It is the writer's belief that the development of Pangnirtung Pass was bound up with the intensity of jointing of the underlying rocks parallel, transverse, and at acute angles to the axis of the present pass. The numerous glaciers on the peninsula carved out the hanging valleys along structural lines of weakness, and these grooves seem to be controlled primarily by joints rather than faults. In the field no definite signs of large scale faults, or faults with large displacements were seen, but their presence, especially those of the graben type, may perhaps be deduced from a study of the field data and air photographs. Small displacements have been seen, at any rate, especially along Pangnirtung Pass and Highway Glacier, in the form of so-called mylonites. The Precambrian-type granitic rocks appear to fail, when under great stress, in the "dry" state rather than plastically.

Because no recent accumulations of sediments have been found on the basalt flows in the Padloping area, and the agglomerates appear to be of submarine origin, it is assumed that the land mass represented by the original basalt sheets between Cape Searle island and Cape Dyer has risen perhaps 800 to 1,400 feet above the sea since the close of vulcanism, and the erosional debris from that mass has since been sedimented under the waters of Davis Strait.

Geomorphology. By H. R. Thompson

The expedition's two geomorphologists undertook very different types of research. W. R. B. Battle concerned himself almost exclusively with the problem of corrie formation, extending the work which he had previously done in the Alps, in Norway, in east Greenland, and in the laboratory. On June 6 he set up a four-point Taylor thermograph at the mouth of a bergschrund in the corrie glacier immediately south of the Base Camp. Short leads were arranged to measure the temperatures of the open air and of the surface snow. Two long leads were taken 90 feet down into the bergschrund, to record air and ice temperatures in the zone where Johnson's bergschrund hypothesis requires repeated freeze-thaw action. Battle had hoped to insert

Photo: W. R. B. Battle

Fig. 11. Thompson on ice-cored moraine of Turner Glacier.

one lead into bedrock itself, but, as in the other bergschrunds and caverns he visited, the headwall was sheathed with a thick coating of ice. Battle checked the thermograph regularly until July 11, when the last seven-day record sheet was put in. The thermograph pens gave considerable trouble, especially in the early days, but enough traces are available for a valid analysis of thermal conditions in spring and early summer.

At the Base Camp site Battle used thermistors and a Wheatstone bridge to measure temperatures at numerous points on, in, beneath, and around a snow patch. The readings, taken every two hours for one day, were repeated on several occasions and led to the general conclusion that freeze-thaw action beneath snow banks and in deep bergschrunds must be a rare occurrence.

Ben Battle's researches ended with his tragic death on July 13. His results are now being analyzed by the writer.

I myself made a geomorphological study of Pangnirtung Pass as a whole. Each main type of landform was first examined separately. Then attention was focussed on assemblages of landforms, on the relation between one element of the landscape and another. Later it became possible to divide Pangnirtung Pass into three geomorphological sections and finally to produce a tentative chronology for the evolution of the whole region. Particular stress was laid on accurate description, which is the main function of such a reconnaissance study. Schwarzenbach's ecological-dating studies were of great value to me and usually confirmed the geomorphological evidence.

A five-inch surveying aneroid was used for height determinations at significant points: about 180 such spot heights were recorded, some of them

in the course of systematic traverses. Slope angles of all kinds were measured with an Abney level, which also provided measurements of height for a plane-table survey of the central part of Pangnirtung Pass. This survey showed that considerable glacial retreat and thinning had taken place in the five years since the R.C.A.F. air photographs were taken, as also in the twenty-seven since Soper's journey through the pass.

The geomorphological work was extended southwards in a more general way as far as Pangnirtung itself. In particular it included 48 soundings with a bathythermograph, recording temperatures as well as depths, on five crossings of the sea ice in the upper reaches of Pangnirtung Fiord.

Pangnirtung Pass is a trough sixty miles long, one mile wide, and up to one mile deep, which cuts from north to south across an old erosion surface of low relief. Hanging valleys and larger valleys at lower levels join the pass at frequent intervals, especially in the central and southern sections where the mountains are highest and most heavily glacierized. The great majority of the tributary valleys contain glaciers with fresh moraines: the moraines are believed to have been formed within the last seventy years and the glaciers themselves are now wasting back and rapidly thinning. There was also an earlier advance of the hanging glaciers. Before that time the whole of Pangnirtung Pass and Pangnirtung Fiord was occupied by trunk glaciers which flowed north and south from the summit of the pass, where even today there is a concentration of large glaciers. The apparent absence of raised beaches along the margins of Pangnirtung Fiord suggests that the southern trunk glacier may have been in existence throughout the latest marine transgression.

Evidence based on geological structure, valley gradients, directions and volume of former ice flows, drainage patterns, and other factors supports the view that Pangnirtung Pass *could* have been excavated by local rivers and glaciers: it is not necessary to assume through-flowing glaciers from north or south of Cumberland Peninsula, though these may well have existed.

Zoology. By A. Watson

The zoological work included collecting specimens of the local fauna and biological studies of some species, especially the breeding birds.

The first two weeks of the expedition were spent travelling by sledge from Padloping to the neighbouring outer islands, and included a visit towards the end of May to the fulmar colony on Cape Searle island.[1] It was estimated that not more than 25,000 fulmars were in occupation of the colony at this time, and that open water was only about three miles away. No sign of breeding was noticed and the gonads of several specimens did not appear from external examination to be in full breeding condition. In a sample count of 446, 79 were of the light, white-headed colour phase.

Later, the Biological Camp in the Owl valley was reached after travelling up Padle Fiord and the June River. Permanent camp was set up there in

[1]Wynne-Edwards, V. C. 1952. "The fulmars of Cape Searle". *Arctic*, Vol. 5, pp. 105-17.

Photo: J. A. Thomson

Fig. 12. Biological Camp looking up Owl River towards Mt. Battle and Mt. Asgard.

early June and work was concentrated on a 7-mile-long stretch of the main valley for the next two months.

This summer lemmings were abundant in both the Padle and Owl river valleys. Although both genera (*Lemmus* and *Dicrostonyx*) were present, the great majority were *Lemmus*. In the same area, examination of lemming bones from old owl nests showed that in three different previous years *Lemmus* was also dominant.

It was not surprising to find snowy owls, *Nyctea scandiaca*, common. A special study was made of their breeding biology and behaviour, lasting from incubation time until after the young could fly. One bigamous male was found and at least four other males were monogamous. The average clutch size of 6 nests was 8 eggs.[1] At several nests a fairly continuous record was kept of such events as hatching, food, and growth rates of the young. In the owl pellets, the lower jaw bones of the lemmings nearly always remained intact. These were used for quantitative and qualitative estimates of the food eaten by the young. After human invasion of the nesting area or of favourite perching places, the owls showed aggressive and often distraction behaviour. At these times their reactions became confused and a variety of marked "displacement activities", such as displaced coition, hunting, and tearing up of prey, were frequently observed.

From study of the breeding passerine birds, it was clear that the habit of re-using nests built in previous years, discovered in redpolls and wheatears

[1]Two with 9 eggs; 2 with 8 eggs, and 2 with 7 eggs.

Photo: J. A. Thomson

Fig. 13. Watson fishing at Biological Camp.

Fig. 14. Snowy owl and young near Biological Camp.

Photo: J. A. Thomson

at Clyde in 1950,[1] also occurred in this area. Pipit, snow bunting, redpoll, and Lapland longspur were found re-using old nests. In these species incubation usually began with the laying of the first egg. This resulted in a spread in hatching and fledging. Territorial behaviour was either lacking or else minute in comparison with temperate regions. There was a marked drop in singing activity in early July; shortly after this time the size of testes from snow bunting and longspur specimens rapidly decreased, and the moult began. Most of the passerine birds left the area about the end of July to early August. There was evidence of a migration route through the pass, used by common and king eider ducks moving north in the latter part of July, and by passerines moving south in August. Common redpolls, *Acanthis flammea*, reared young in several places in the Owl and June river valleys, but only a few hoary redpolls, *A. hornemanni*, were seen.

Arctic fox, weasel, and ptarmigan were all uncommon, and only a few broods of ptarmigan were found in the whole pass. A single caribou was seen by the expedition. Several arctic char were taken in the small stream and lake just south of the Biological Camp, and collections of invertebrate animals were also made, especially insects, spiders, and freshwater fauna. Thirteen mammal and thirty bird specimens were collected.

Botany. By F. H. Schwarzenbach

The main purpose of the botanical work was to compare the plant communities of the Penny Highland with the vegetation of the arctic mountains of east and north Greenland.

During the summer a comprehensive collection was made of the vascular plants in the Pangnirtung Pass area, including large numbers of critical species of the genera Poa, Draba, Salix, Luzula, Melandrium, and Antennaria. In addition some mosses and lichens and a large number of epiphytic fungi were obtained.

The flora of the region consists of about 100 species. The small number is due to the absence of the calcicolous element and of species from coastal areas. The taxonomic work will be done in Canada and in Switzerland. Special studies were made of the ecology of vascular plants, especially of species which are absent in Greenland.

The writer spent the first four weeks assisting in the seismic work, but was able to fit in three field days in the region of Highway Glacier comparing the vegetation of isolated nunataks and determining the altitudinal limit of the vegetation. Two periods were spent at the Biological Camp. On the first, a detailed survey was made of the flora and plant communities, and a two-day reconnaissance trip taken to the upper lake in the June valley, thence across a 2,600-foot pass to the upper Naksakjua valley. Later, comparative studies were started. At the Base Camp ten days were spent studying ecological problems and making observations of the development of plant

[1]Wynne-Edwards, V. C. 1952. "Zoology of the Baird Expedition (1950). 1. The birds observed in central and south-east Baffin Island." *Auk*, Vol. 69, pp. 353–91.

communities. On the second visit to the Biological Camp the changes in the vegetation since the earlier visit were noted and detailed work carried out on some species. A reconnaissance trip was made to the upper Naksakjua valley and thence to Tundra Lake, where a profile was taken of the vegetation from its limit at 3,600 feet to the birch belt at 500 feet around the lake. The remainder of the summer was divided between the Base Camp, where three vertical profiles were obtained of the vegetation and analyses made of the food of lemmings and birds for Watson, and the south Pangnirtung Pass area where the vegetation was studied.

The region to the east of the Pangnirtung Pass proved the most interesting. In the June and Naksakjua valleys the vegetation contained numerous relicts of a warmer period, which compare with relict vegetation found in the mountains east of the Penny Icecap. By contrast, the Owl River valley, only a few miles to the west, has a very young vegetation which must have invaded the valley during the last 150 years only.

The summer's work showed that the vegetation in the Penny Highland and in the mountains of east and north Greenland is basically the same, with only slight differences caused by local climate and local groups of species. The higher precipitation in the Penny Highland results in a relative dominance of cryptogams, and some special ecotypes in the genera Poa, Potentilla, and Melandrium deviate from the Greenland ecotypes. The altitudinal limit of vegetation in the Baffin area was about 3,600 feet on west-facing slopes, a low figure when compared with 3,300 feet in northeast Greenland north of 80 degrees.

Mountaineering and surveying. By J. Marmet

From the Base Camp the highest mountains of Baffin Island were accessible. In this region there were so many large peaks, some capped with ice, others sharp and outstanding, that it was difficult to select the most beautiful and interesting peaks for climbing. As part of the climbing program we planned to determine the heights of the highest mountains.

The time for mountaineering was limited by the progress of the scientific work. Baird and the Swiss seismic team had planned to stop work for two weeks during the best period for mountaineering, but were held up for some days at the Base Camp, and then by poor weather at the mountain cache (M on the map). After 5 days waiting in a small tent without being able to see more than a hundred feet through snow or rain, the group decided to return to the Base Camp and to continue the seismic work.

However, eight peaks were climbed between periods of scientific work. Mt. Battle (4,420 feet), above the Base Camp, was climbed first by Baird, and later by most of the expedition members. From the top there was an excellent view of all the glaciers round the Base Camp. Weber climbed a high flat snowpeak (c. 6,900 feet) to the east of Camp A2, and Marmet climbed a high snowpeak (c. 6,930 feet) to the south of A2 for survey work. Together, on June 27, Marmet, Röthlisberger, and Weber climbed a big rock tower

(5,180 feet) behind Camp A3 by a long gully and a rock face 300 feet high. The tower gave a wonderful view of Highway Glacier from the ice cap down to the snout.

Two days later they climbed Tête Blanche (7,073 feet), later shown to be the highest local mountain, by the northwest ridge, and had a difficult descent in poor weather. On July 13, a fine clear day, the four Swiss members climbed Mt. Asgard (6,596 feet), a very impressive rock tower. The rock climbing was extremely difficult, and the whole excursion took 25 hours. On August 5 Marmet climbed an outstanding peak (6,440 feet) to the southeast of A3. The most beautiful and second highest mountain (7,014 feet), which we called The Queen, was climbed by Baird and Marmet on August 25 in a 12-hour excursion by a long gully, snowfields, and a rock ridge, which necessitated some step-cutting and difficult climbing. Three days later this peak was climbed by three other members of the expedition.

A small, light Wild T 0 theodolite, was taken for the mountaineering survey work. It was first used on the snowpeak to the south of A2, which Marmet climbed on a fine day with unlimited visibility, after three unsuccessful attempts because of poor weather. Some days later the theodolite was carried to the top of Tête Blanche, and the angles of 10 high mountains and Camps A1, A2, and A3 were taken before the weather suddenly changed while the party was on the summit. This survey showed that any one of three mountains might be the highest, but that the T 0 theodolite was not accurate enough to determine such small differences.

Therefore, towards the end of the expedition, a new base was measured at the Base Camp with the more accurate Wild T 2 theodolite. The angles of 25 mountains were taken with this instrument from the summits of Mt. Battle and an unnamed peak (4,950 feet) to the northeast of Glacier Lake, and it was found that Tête Blanche was the highest. The determination of the refraction was very difficult, if not impossible, during this short period which was broken by some days of bad weather. To get the absolute altitude of the base at the Base Camp another base was measured on Pangnirtung Fiord and the angles taken of four mountains that had also been measured from the Base Camp region.

Photography. By J. A. Thomson and J. R. Weber

The photographic coverage of the expedition included motion and still pictures. With a 16 mm. Cine K. Kodak and telescopic lens 3,700 feet of colour film were exposed, covering the arrival at Pangnirtung, setting-up of camps, living conditions, work at each camp, and transportation, including a dog-team trip up Pangnirtung Fiord. The opportunity also occurred to shoot scenes of a white whale hunt with Eskimo boats. A Busch Pressman 2¼ x 3¼ plate camera was used for black and white photography. Film was provided by the expedition for those members who brought their own cameras. From all this material a collection of colour transparencies and black and white prints will be made for the Institute. J.A.T.

A second cine camera, a Paillard H16, with a "Macor" reflex focussing device for micro-cinephotography, was provided by the Swiss Foundation for Alpine Research. With this camera, 2,200 feet of colour film were exposed, covering mainly the activities of the Swiss team, the flight to the ice cap, seismic work, biology (breeding birds, close-ups of flowers and insects), mountaineering, Eskimo life, and a seal hunt. The Swiss members also took still pictures, using 3 Exacta-Varex cameras for colour photography, and a Rolleicord 6 x 6 cm. for black and white. J.R.W.

New Names

The following names have been approved by the Canadian Board on Geographical Names:

Coronation Fiord: Coronation Glacier flows into this fiord.

Coronation Glacier: First reconnoitred by us on the day of Her Majesty's Coronation.

Fork Beard Glacier: The ice of this glacier divides and falls in two rippled tongues to the valley floor.

Highway Glacier: The main expedition route from Base Camp to the Penny Icecap.

Maktak Fiord: Abbreviation of the local Eskimo name Maktartudjennak (Boas map), meaning the place where one eats white whale skin.

Mt. Asgard: Spectacular rock tower resembling the Norse gods' home illustrated by Van Loon.

Mt. Battle: After the late W. R. B. Battle, a member of the expedition.

Mt. Fleming: After the late Bishop Archibald Fleming, Anglican missionary.

Naksakjua River: Local Eskimo name, meaning Big Valley.

Owl River: Many snowy owls nesting here in 1953.

Penny Icecap: The general region here was named Penny Highland by Boas.

Rundle Glacier: After the late Nurse Rundle of Pangnirtung.

Tête Blanche: Ice-domed highest peak.

Turner Glacier: After the late Rev. H. A. Turner, for many years a missionary at Pangnirtung.

Weasel River: A tiresome number of weasels here in 1953.

The names above appear on Fig. 4, and are published for the first time. The following names were also approved by the Board, but are outside the area of the map:

Greenshield Lake: After Rev. E. W. T. Greenshield, Baffin Island missionary. For the 17-mile-long lake on the west side of the Penny Icecap.

Kumlein Fiord: After Ludwig Kumlein, the naturalist with the Howgate expedition 1877–8. A colony of the gulls named after him nests on a cliff in this fiord, which is the large inlet to the north of Abraham Bay, east side of Cumberland Sound.

ENGLISH FISHERY RESEARCH IN NORTHERN WATERS

Michael Graham*

THE research trawler *Ernest Holt*—named after a pioneer fishery naturalist—was built for the Ministry of Agriculture and Fisheries to carry out hydrographical and biological research in the area of the English arctic fishery at all seasons of the year (Fig. 1). In 1949 it was believed that work in the Barents Sea would be possible through the winter, given a sufficiently good sea-ship, which she has proved to be, and one that is generously heated and lighted. The effects on the operators of darkness, cold, and bad weather, have not usually proved serious, and no explorers' hardships have had to be endured; nor any heroic feats performed. Nevertheless, it may be noted that the margin of practicability has not been large. It has been necessary to reduce all operations to the simplest possible form, foregoing anything too clever, either in apparatus or in aims. For example, at the beginning the number of thermometers lost or broken was lamentably high, higher than could be readily explained to those who had not participated in the work. The circumstances of every loss or breakage have been reviewed, and have always been found to be due to some mistake in handling that the staff would not normally be expected to make. Apparatus and procedure have therefore been simplified, although it has proved impossible to dispense with the highly accurate mercury-in-glass thermometers. However, after the simplification, losses have not been serious.

The Master of the *Ernest Holt*, formerly Captain W. R. Ingham, now Captain H. J. Aldiss, has found it just possible to navigate in the regions where either the sky or the horizon is nearly always obscured by fog, cloud, or snow-storm, even in summer. It has been found necessary to engage a Navigator, Mr. E. A. Binnington, in order to keep track of all the ancillary information from radar, W/T, and soundings, such as they are on charts on which even the position of the land is not always free from doubt.

The ship herself looks like a commercial arctic trawler, except that she is painted like the other research vessels of the Ministry: black hull, white upper-work, and buff funnel crowned black. On the fly of her Blue Ensign is the dolphin and crown of the Fisheries Department's ships. The over-all length is 193 feet; length (b.p.) 175 feet; breadth 30 feet, and depth 16.0 feet. Her oil-fired triple expansion engines develop 900 I.H.P. giving her a cruising speed of 11 knots.

Her workmanlike trawler appearance results from a deliberate decision to preserve a trawler's ample deck-space, and the stability that comes from absence of top-hamper. This necessitated putting the main laboratory below

*Director, Fisheries Laboratory, Lowestoft, England.

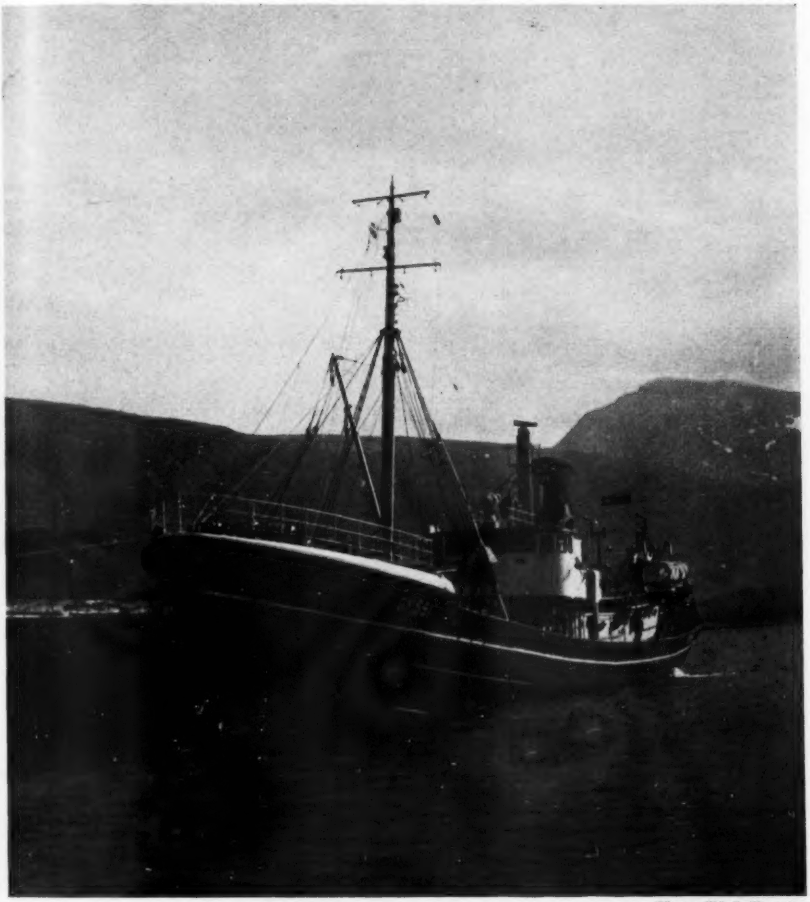


Photo: W. J. Huggins

Fig. 1. The *Ernest Holt* in Tromsø, her refuelling port.

decks, a decision that has not been regretted. The main laboratory and living accommodation occupy the space usually allotted to the fish-room, which in the *Ernest Holt* is small. She does from time to time land and sell a few hundred pounds' worth of fish. Space has been found, however, for small working laboratories on deck, one hydrographical and one biological, where material is first examined and reduced to the smaller bulk that can be transferred down to the main laboratory in a small elevator.

Skipper John Monger has trained his crew to work the trawl as well as any other fishermen in the area, so that information on this ship's catch means something definite to other fishermen; but here too, the requirements of research have demanded just that much more, which has only just been

Photo: H. O. Bull

Fig. 2. Trawling in poor weather in the Subarctic.

Fig. 3. Trawling stopped by storm.

Photo: H. O. Bull

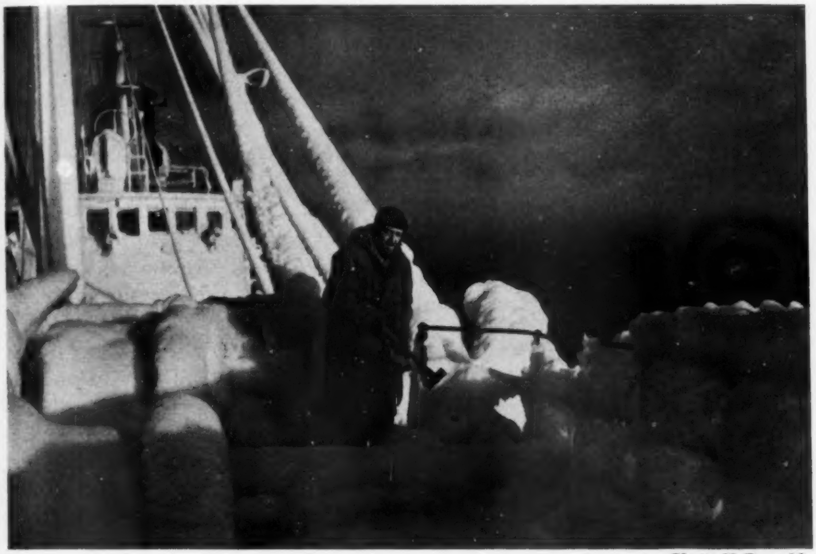


Photo: N. Reynolds

Fig. 4. Removing ice after the storm.

achieved. In the abominable month of March, most trawlers work in the more southern parts of the Barents Sea, and only hang near the ice of the Bear Island Shelf if fishing elsewhere is desperately bad. But research required that there should be no seasonal gap in information, and all months have found the ship fishing near Bear Island (Bjørnøya) and to the north-eastward towards Hope Island (Hopen). There have been two deckhands injured. One had an elbow crushed when it was caught where, in normal latitudes and weather, a man would not have been foolish enough to put his elbow, and even one man injured is one too many, and is an indication that in this department too, the *Ernest Holt* has no margin to spare (Fig. 2).

Deck engines form the Achilles heel for the Chief Engineer, Mr. J. H. Van Ham and the 2nd Engineer, Mr. A. Baggott. After two fully qualified engineers were engaged, in place of only one, there has been no further trouble; but before that time there was a sad history of electric and steam winches in trouble when nobody expected it, spray seeping into an electric winch, or sudden frost cracking the cylinders of a steam one. In extreme cold the oil in bearings sometimes goes solid, and it was a heartening sight to see Skipper Monger light a bonfire under the main winch, which freed it after normal engineer's methods had failed. Rather surprisingly, despite the care necessary to prevent freezing, our preference is for steam winches rather than electric. The human factor is easier with steam than with electricity.

About seven voyages are made in the year, with an average duration of twenty-nine days. Naturalists-in-charge are drawn from an Arctic Team consisting of the following: M. Graham, G. C. Trout, A. J. Lee, R. J. H.

Beverton, J. Corlett, and R. W. Blacker. The four members of the scientific staff on board do their best to work up both their biological and hydrographical observations in a preliminary fashion by the time each voyage is ended. Then the plan for the next voyage can be made to fit on to what has been found already. Continuity is maintained by a somewhat strict hand-over to the next naturalist-in-charge when the ship returns to Grimsby. By then the old naturalist-in-charge has fair charts of his observations, and as full a report as possible of the findings of his voyage. So, hearing all this, the new naturalist-in-charge can then and there make his preliminary plan for the next voyage, and discuss it with the Master and Fishing Skipper before the ship turns over to harbour routine. If necessary, the new naturalist-in-charge stays by the ship until he is sure that all preparations for his voyage are in train.

As soon as possible after the returning staff reaches the Fisheries Laboratory, a meeting of the whole team is held, at which the program for the next voyage is discussed, after which it is drafted and issued, serving as the starting basis.

As the ship steams north again, information about fishing and ice conditions begins to come in, and by the time the area of investigation is reached, the naturalist-in-charge may have modified his plan considerably. Success has sometimes depended on still further modifications as the work develops on the grounds; for which purpose it is advantageous to have the scientific staff so strong—usually three professional men and one assistant—that the naturalist-in-charge may devote himself entirely to monitoring and meditation, leaving his staff to carry out all the more strenuous work. This has not always proved possible, and it has been difficult to convince young and zealous naturalists-in-charge of its value.

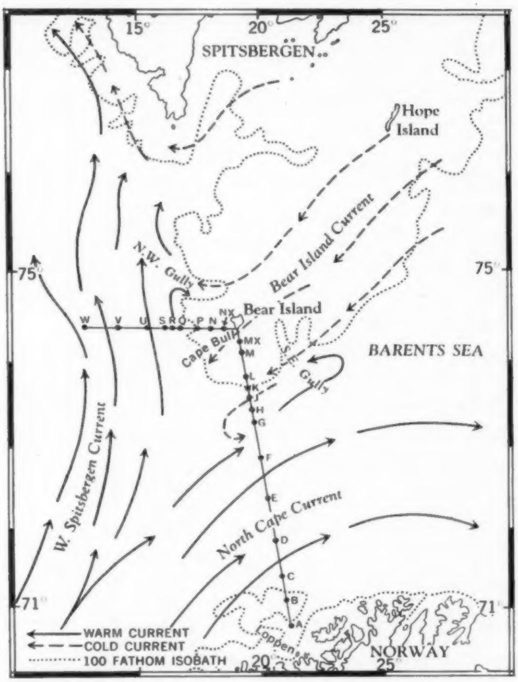
Once a year, a program conference of the Arctic Team sits for as many days as are necessary to produce proposals for the next year's work.

In general, the scientific attack has been by the method of hypothesis followed by critical observations, rather than by survey and statistical evidence. As time has passed, hypotheses have tended to become more comprehensive, and in 1953–4 one is under test for the Hope Island area, involving a seasonal progress in nutrient salt content, phytoplankton, zooplankton, capelin, cod, fat-content, and vitamin content, with the retreat of the ice as the governing factor, and the understanding of a particular summer fishery as the immediate economic prize. At present that fishery is unpredictable and irregular, needing scientific elucidation. It was bad luck that in 1953, as it happens, there was not a sign of it. Understanding of that fishery might well lead very much further, with applications to all "subarctic" cod fisheries (Dunbar, 1951, 1953), popularly termed arctic.

Other areas investigated, but more superficially as yet, are near south Greenland, Jan Mayen Island, west and north of Spitsbergen, and Goose Bank near Nova Zembla (Novaya Zemlya).

In the meantime, definite advice has been given to fishermen for the months of May/June, October, November, and December, when they could use reversing thermometers with advantage. The main fishery investigated has been that on the Bear Island Shelf, where immature cod can be trawled

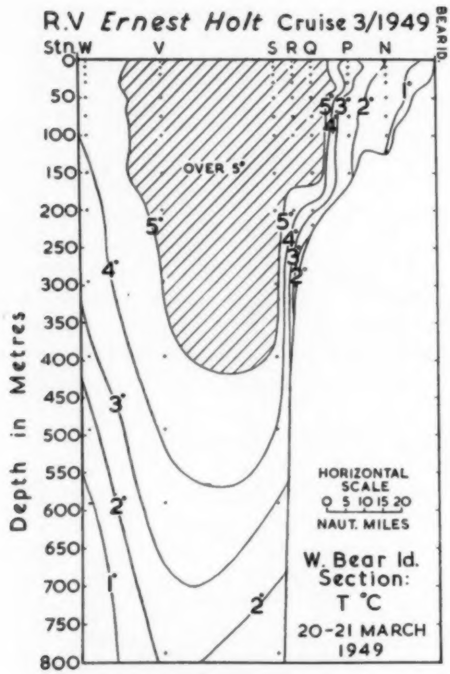
Fig. 5. General current system of the western Barents Sea and the two standard hydrographical sections.



sometimes in prodigious numbers. The stock has been found to be localized in the boundary region of the West Spitsbergen Current, of Atlantic water, and the Bear Island Current, of arctic water (Fig. 5). The latter has a temperature of less than 2°C; it is a mixture of meltwater, mainly of polar origin, with a temperature less than 0°C, and of Atlantic water, originally of temperature of more than 4°C, some of which has travelled round Spitsbergen and returned to the Barents Sea through the channel between Spitsbergen and Franz Joseph Land (Zemlya Frantsa-Iosifa). Not only is the cod fishery located in the general boundary region, but in certain months and localities, success in finding paying concentrations, yielding a ton and a half per hour's trawling, depends on the presence of local pockets or inversions–hydrographic structure caused by the impact of the two kinds of water. This was the main finding from the first four years' work.

Arctic workers in general may be more interested in the oceanographical observations, which are intended to form a contribution to the problem of warming and cooling of the Arctic, as it affects fisheries.

Two hydrographical sections were set up (Fig. 5): the "South Bear Island Section" from Loppen (Lopphavet) in northern Norway to Cape Bull (Kapp Bull) in Bear Island, to monitor the North Cape Current and other movements in this entry to the Barents Sea; and the "West Bear Island Section", running from Bear Island out into the deep water to the westwards, so keeping



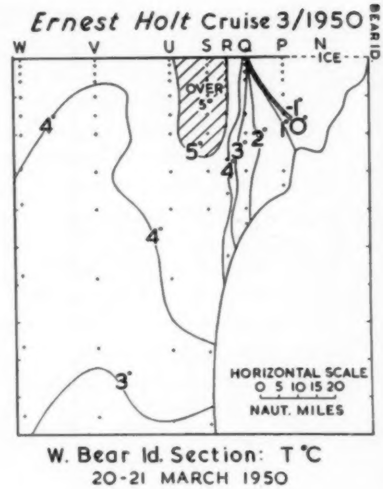


Fig. 6. Atlantic and arctic water. Temperatures on the West Bear Island Section.

a watch on water transport in the West Spitsbergen Current. Observations are made at the standard depths internationally agreed, and most of the stations are between 5 and 25 miles apart (Fig. 6). The original aim was to make both these sections four times per year, but it was found that the southern section was not so profitable as the western, and it has been done less frequently. In addition, surface and bottom temperatures have been taken wherever the ship found herself in all her work; and a surface thermograph has been run during most cruises. There have also been numerous bathythermograph lowerings.

The bearing of these observations on long-term warming and cooling will not be clear until several more years have passed. In the meantime, however, various oceanographical phenomena have begun to be revealed, at least in part. Sharp discontinuities in density of the water are found at certain seasons of the year, both horizontal and vertical. These are sometimes multiple in depth, and are shown by both bathythermograph and echo-sounder. The strength of the Atlantic component on the Bear Island shelf is subject to wide variation, and its interplay with the arctic component, itself varying with winter ice conditions, appears to produce one or another type of condition on the shelf, these in turn giving different types of fishing in one year as compared with another (Lee, 1952).

The nutrient salts and dissolved oxygen content of the water are proving interesting, both to hydrographers and to biologists; and the faculties meet also

in the study of benthic animals, which may provide information either on the frequency of extreme hydrographic conditions in different areas, or on the average conditions.

Incidental activities of the *Ernest Holt* have included: measuring current by plotting movement of icebergs; making a hydrographical station in latitude 80°38N.; correcting the tidal information for Bear Island; adding soundings to the charts; leading fishermen to many thousands of pounds' worth of fish; fishing once among many Russian trawlers some 150 miles east of any British ones; and the rescue and salvage of a Norwegian sealer.

It would be an omission of the relevant if I failed to mention that all this is very enjoyable. That—and indeed all else—has been made possible by the ship's outstanding sea qualities. Wind of Force 12 has not harmed her, and she takes the water easily, fore or aft or on the beam. To achieve this we took, in the first instance, deckhands' advice on which existing arctic trawler was kindest to them, and then ordered one to be built with the same hull. The builders gave her more beam, and certain other modifications—all helpful it seems. She must be one of the best sea-ships afloat: that, at least, is the opinion of those who sail in her.

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A METHOD FOR MEASURING THE MOVEMENT OF ROCKS AND GLACIERS WITH SIMPLE EQUIPMENT

E. de Haas*

Since the beginning of 1953 experiments at the Laboratories of the Hydro-Electric Power Commission of Ontario with the method of van Heel (see references) for precision alignment have shown it to be very suitable for measuring small deflections, such as movements of rocks and glaciers.

The basic idea is that three marks are placed on a line with, say, 400 feet between the outer two. They are: a single slit, about 1/32 inch wide, illuminated by a 100-watt projection lamp with condenser lens (Fig. 1); a double slit (Fig. 2), and a 3x eyepiece with a scale (Fig. 3).

The light, originating at the single slit, undergoes diffraction at the double slit, and results in an interference pattern consisting of coloured bands which can be observed with the eyepiece. The set-up resembles the well-known "High School" Fresnel experiments for demonstrating that light is a wave phenomenon.

The applications are based on the fact that the coloured lines are very sharply bounded and that the pattern is symmetrical about its centre. The centres of the first slit, the second slit, and the pattern can always be lined up with great accuracy. Once adjusted the marks can be left in the field for days or months. Any sideways deflection (p) of the double slit (D_1) (Figs. 4 and 5) results in a corresponding sideways deflection (q) in the pattern at the eyepiece scale (P) where

$$q = \frac{c_1 + c_2}{c_1} p \quad \text{or if } c_1 = c_2$$

$$q = 2p$$

c_1 is the distance between the first slit and the double slit, and c_2 between the double slit and the eyepiece scale; q is measured on the eyepiece scale as the difference of the average readings of symmetrical coloured lines before and after the deflection occurred.

Using this method we have been able to obtain in the open air on a 400-foot span an error in q as small as 2 mils (0.002 inch) which corresponds to an error in α of

$$\triangle \alpha = 0.09 \text{ seconds of arc}$$

Working in the enclosure of an 1,100-foot-long inspection tunnel in a concrete power dam we succeeded in spanning a distance of 1,000 feet with an error in q of 3–4 mils, which corresponds to

$$\triangle \alpha = 0.06 \text{ seconds of arc}$$

*Assistant Engineer, Laboratory, Hydro-Electric Power Commission of Ontario.

Fig. 1. First slit, illuminated by projection lamp.

Fig. 2. Double slit, placed between first slit and eyepiece.

Fig. 3. Eyepiece.

With the present equipment 1,000 feet seems to be the upper limit for convenient operation. A longer distance can be bridged, however, by dividing it up and placing stands at the beginning and end of each section, where each stand is lined up with reference to its two neighbours.

For the study of rock and glacier movements it is suggested that the outer two marks be mounted on solid rocks and the centre mark on the moving rock or glacier.

In our experiments we have made the eyepiece removable and used as the third mark a pointer fixed to the stand. The deflections of the pattern are

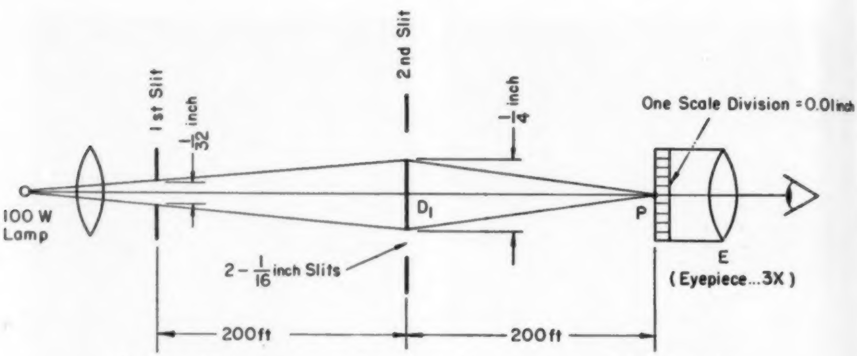

Fig. 4. Alignment method with simple equipment: original position.

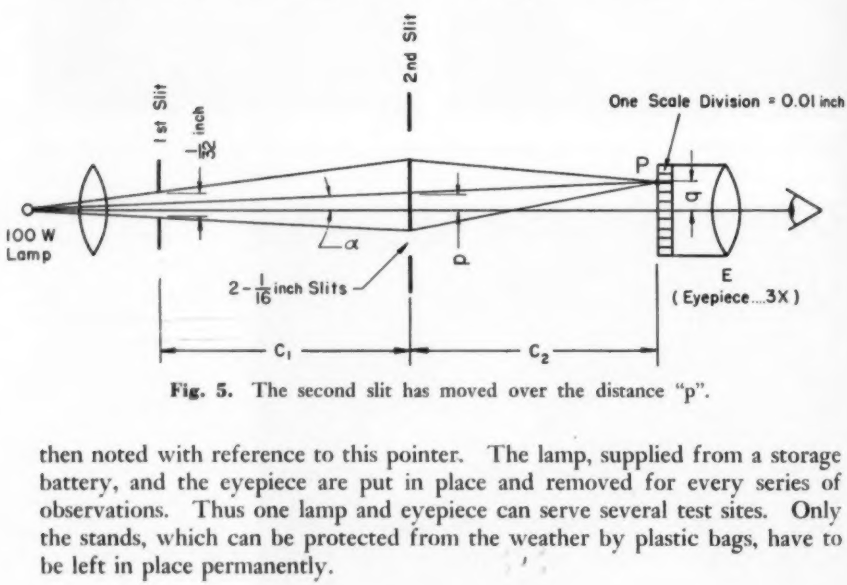

Fig. 5. The second slit has moved over the distance "p".

then noted with reference to this pointer. The lamp, supplied from a storage battery, and the eyepiece are put in place and removed for every series of observations. Thus one lamp and eyepiece can serve several test sites. Only the stands, which can be protected from the weather by plastic bags, have to be left in place permanently.

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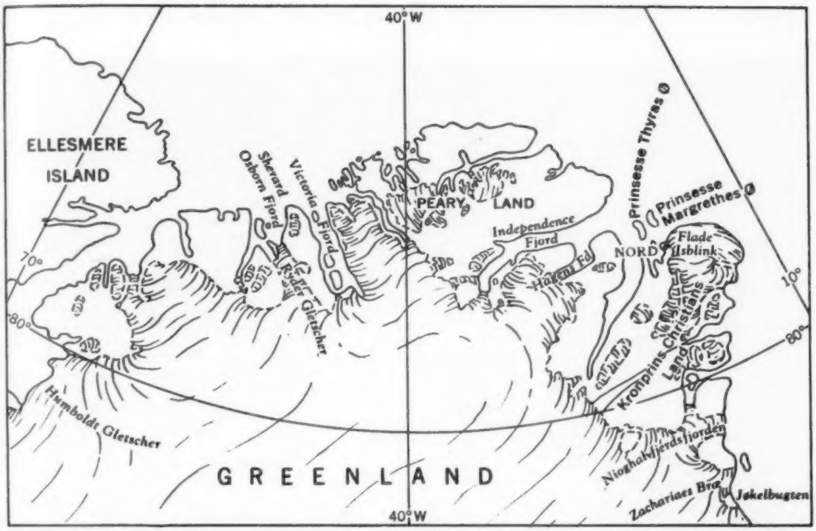

Fig. 1.

ICE ISLANDS: EVIDENCE FROM NORTH GREENLAND

J. V. Helk* and Moira Dunbar†

FOLLOWING the article on ice islands published in the July 1952 number of *Arctic*[1], Captain Leverett G. Richards of the United States Air Force Reserve[2] sent us a coloured slide of a large piece of ice in northeast Greenland which showed considerable resemblance to the ice islands. He had taken the photograph near Prinsesse Thyras Ø, when flying supplies to the Nord weather station in Independence Fjord. Through Captain Richards we were put in touch with Lieutenant-Colonel J. V. Helk of the Danish Geodetic Institute, who has sent us a collection of air photographs of areas in north Greenland in which ice reminiscent of the Ellesmere shelf occurs. A few of these photographs are reproduced here with Colonel Helk's comments.

The areas in question are: Sherard Osborn and Victoria fiords, on the north coast; Kronprins Christians Land and Independence Fjord, in the northeast corner; and the east coast between 78° and 80°N. Colonel Helk, who from the first has been closely connected with the photographing of Greenland, is reasonably sure that these are the only areas in north Greenland where ice of this nature is to be found. EDITOR

*Chief, Photogrammetric Division, Geodetic Institute of Denmark.
†Arctic Research Section, Defence Research Board of Canada.
[1]Koenig, L. S. *et al.* 1952. "Arctic ice islands". *Arctic*, Vol. 5, pp. 67–103.
[2]Now aviation editor of *The Oregonian*.

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Fig. 2. Mouth of Sherard Osborn Fjord. Taken 27 July 1952 at 4,000 metres (13,000 feet).

Notes on the photographs. By J. V. Helk

Sherard Osborn and Victoria fiords

Fig. 2 shows Sherard Osborn Fjord, looking up the fiord, with the snout of the Ryder Gletscher in the background. In the foreground are some of the large bergs from the glacier, the largest about 2½ x 2 miles (nautical miles). Fig. 3 shows the mouth of the fiord, with more bergs. The latter would be hard to distinguish from small ice islands.

The bergs in Victoria Fjord are in some respects like those in Fig. 2, but smaller and much more worn down by melting. Though somewhat similar to the Ellesmere shelf, the ice in these fiords lacks the large rolls typical of the shelf.

Kronprins Christians Land

The northern part of Kronprins Christians Land is covered by an isolated ice cap, Flade (flat) Isblink (Fig. 4). This ice cap is apparently inactive. On

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Fig. 3. Sherard Osborn Fjord, looking inland. Taken 27 July 1952 at 4,000 metres (13,000 feet).

the east side it is stagnant and the northern edge appears to be disintegrating into flat-topped bergs.

Prinsesse Thyras Ø

Fig. 5 shows an "ice island" which lies between Prinsesse Thyras Ø and Prinsesse Margrethes Ø. This "island" actually consists of two very different parts. The northern quarter is flat and appears to be without rolls, but there are narrow snowdrifts running north and south; the rest is slightly higher, especially in the middle, and has broad rolls running roughly east and west, with the north–south snowdrifts superimposed. The northern part looks very much like old sea ice, while the southern part resembles ice found on the east coast (Jøkelbugten, see Fig. 8). The "island" lies very close to Prinsesse Thyras Ø but is not attached to it.

It is hard to tell whether this is a relic *in situ* of a larger ice shelf or whether it was formed elsewhere and drifted to its present position. The depth of water in the area is not known, but it seems likely from the number and

flatness of the islands that it is shallow. The ice could therefore easily be grounded *in situ*. On the other hand it would be hard to explain why this piece should have resisted longer than the ice which must once have covered the islands. From available records it appears that the mean temperature in this area is rather lower than on the Peary Land coast and Independence Fjord, and the islands remain snow-covered for longer. Nevertheless the snow does melt and the fast ice breaks up in many seasons. It seems more likely that it has drifted to its present position, possibly from Flade Isblink, and grounded.

It is not known how long this "island" has been there, but it has been travelled over on the ground at least once. In 1952, after the photographs were taken, Count Eigil Knuth travelled along the east coast of Prinsesse Thyras Ø. The visibility was poor, but Knuth noticed strange uneven structures and black areas on the ice in this region.

Hagens Fjord

Fig. 6 shows a very large iceberg in Hagens Fjord, about 3 x 5 miles. This came from the glacier emptying into this fiord and the large number of smaller bergs indicate the glacier's activity. The large berg, though less regular in surface pattern than most ice islands, shows signs of parallel rolls, especially in the lower left corner.

Fig. 4. Flade Isblink, Prinsesse Thyras Ø in left background. Taken 30 July 1951 at 4,000 metres (13,000 feet).

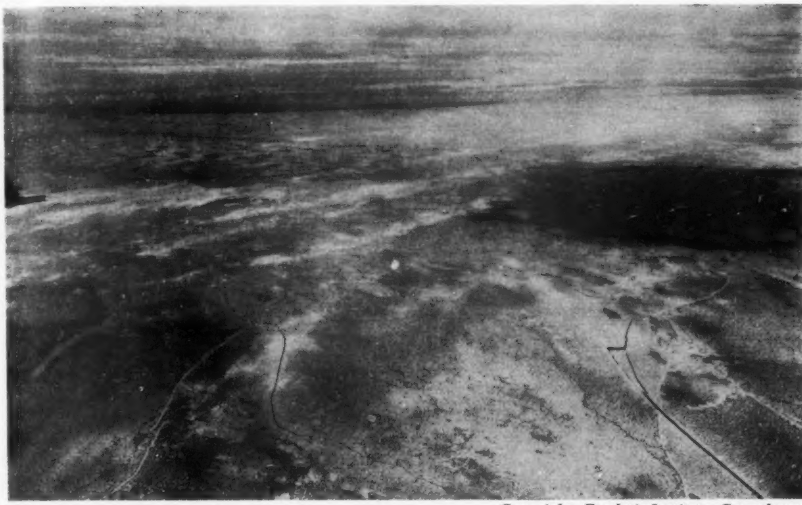

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Fig. 5. "Ice island" off Prinsesse Thyras Ø, part of which is just visible on the left. Taken 11 August 1951 at 3,600 metres (11,800 feet).

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Fig. 6. Large iceberg in Hagens Fjord, looking north. Taken 29 July 1951 at 4,000 metres (13,000 feet).

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Fig. 7. Nioghalvfjerdsfjorden, looking inland up the glacier. Taken 15 August 1950, at 4,000 metres (13,000 feet).

East coast between 78° and 80°N.

Fig. 7 shows Nioghalvfjerdsfjorden (Seventy-nine Fiord), looking up the glacier from the sea. This glacier is moving rather slowly and produces few bergs. These are held fast for long periods by the sea ice, which seldom breaks up.

Fig. 8. A little farther south Zachariaes Bræ (glacier) empties into the north part of Jøkelbugten (Glacier bay). Here too the movement is very slow. The photograph is taken looking inland towards the glacier.

Fig. 9. This photograph shows large fields of ice broken presumably from Zachariaes Bræ. In this part of the bay the sea ice breaks up almost every year, which accounts for the more broken appearance and sharper edges of the pieces.

Comments on the photographs. By Moira Dunbar

These photographs of north Greenland, showing ice of undoubted glacial origin, add evidence in support of the theory that the Ellesmere Ice Shelf is also of glacial origin. Some of the Greenland ice is so like the Ellesmere shelf ice and the ice islands that it would be hard to distinguish them. Indeed some

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Fig. 8. Zachariaes Bræ, Jøkelbugten, looking inland. Taken 15 August 1950 at 4,000 metres (13,000 feet).

of the ice islands photographed in the Canadian Arctic might have come from the Ryder Gletscher–any from the Flade Isblink or the east coast would be unlikely to move westwards round the north coast of Greenland but would go south down the east coast and melt.

At this time Mr. G. F. Hattersley-Smith has recently returned from a visit to the Ellesmere Ice Shelf and will shortly be publishing his preliminary findings. It is therefore not a suitable moment to theorize from air photo evidence only. The following points, however, are worth noting for future consideration when ground data are available as well.

The north coast of Greenland, like that of Ellesmere Island, is a fiord coast with an elevation in the highlands of 3–4,000 feet. The Greenland fiords are longer and wider than the Ellesmere ones but the general characteristics are the same and the fiord glaciers have very gentle gradients. It is fair to assume that at some time in the very recent past, geologically speaking, the same ice cap covered both, thrusting a common front towards the Arctic Ocean. This, when it ceased to be active, would probably look not unlike the Flade Isblink does today (Fig. 4). A glance at the map will show that if the Flade Isblink is considered as part of such an ice cap it would be flowing eastwards at this point. Thus the north–south rolls on Flade Isblink, which apparently run

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Fig. 9. South part of Jøkelbugten, looking east. Taken 15 August 1950 at 4,000 metres (13,000 feet).

with instead of across the direction of flow, would actually show the same direction as is typical of the Ellesmere Ice Shelf.

As the ice retreated nunataks would appear and melting would be accelerated by the heating of the rock, so that it is in no way extraordinary to suppose that the land ice might disappear, leaving a relic fringing the coast which would melt much more slowly and which could break away only in years when the sea ice around it broke up. This is not believed to occur very frequently on the north coast of Ellesmere Island even today, and it may reasonably be supposed that it occurred at least as seldom when the glaciers were nearer the coast. Why the fringing ice has apparently all gone from the Greenland coast, where the glaciers are much more active than in Ellesmere Island, is not immediately clear. It is possible however that some local phenomenon, such as ocean currents, may cause the sea ice to break up more frequently in this region.

The ice on the east coast is the most interesting and the most like the Ellesmere Ice Shelf. One very intriguing feature appears in Figs. 7 and 8; these show small islands which give the impression of having sailed into the ice like so many icebreakers and left channels behind them filled with ordinary sea

ice. It is hard to explain these channels. Presumably the glacier has been diverted around the islands and continued seawards, but it is curious that the ice has neither overridden the very low islands nor flowed together again after the islands are passed. In Fig. 7 too the rolls run parallel to the direction of flow. This direction continues right up the glacier, though farther up there is also a less clearly marked pattern running at right angles to the flow. At the head of the glacier there are no apparent rolls but the surface is heavily crevassed, the crevasses becoming closed or filled in as the gradient flattens out. Most intriguing of all is the series of almost identical pieces shaped like birds' wings in Fig. 7. How they have been formed I cannot even guess, but the pattern seems too marked to be accidental.

The suggestion that Sherard Osborn and Victoria fiords are the only areas on the north coast of Greenland where ice comparable to the Ellesmere Ice Shelf exists today is particularly interesting. In the July 1952 number of *Arctic* (p. 94), I mentioned that Lockwood of Greely's expedition (1881–4) referred once or twice to "undulating ice" on the north coast of Greenland. In fact all these references were made in the vicinity of these fiords.

The results of Hattersley-Smith's expedition and the second one that is planned for 1954 should do much to clear up the problem. I believe however that although ground investigation is of course essential to the study, many significant features are only to be found from an examination of these and other air photographs, and that whatever the final explanation of the Ice Shelf, it will involve the course of events in the glacial history of Greenland as well as of Ellesmere Island.

REVIEWS

GLACIER VARIATIONS AND CLIMATIC FLUCTUATIONS

By H. W:son Ahlmann. *New York: American Geographical Society, 1953. (Bowman Memorial Lectures, Series Three). 9 x 6 inches; v + 51 pages; illustrations, diagrams, and sketch-maps. $2.50.*

When the master of a subject, Hans Ahlmann, speaks or writes upon his favourite topic, glaciology, the profits are great. The third series of Isaiah Bowman Memorial Fund lectures afforded just such an occasion, and the benefits of Ahlmann's words are now made more widely available through publication of this booklet.

Readers familiar with Dr. Ahlmann's former works and aware of his more recent services as Swedish Ambassador to Norway might understandably expect to find herein a summary of earlier accomplishments, but they will be surprised. The present volume is an effective digest of recent glaciological and climatological investigations, organized and interpreted within a framework established largely by the researches of Ahlmann and his colleagues. As a result of his alert and continuing interest in glaciology and related climatic changes and through his widely recognized stature, Ahlmann serves as an effective clearing house for all the latest information in these fields. It is because of this unique position plus his own talents for evaluation and synthesis that the present volume constitutes a notable contribution.

Topics to which consideration is given include: glacier regimens, factors influencing glacier variations, the recent glacier recession and its causes, the present climatic fluctuation and the evidence for it, the position of this fluctuation in the broader sequence of climatic changes, and some aspects of possible future climatic variations. Treatment of these matters is enhanced by inclusion of considerable unpublished material from the Norwegian-British-Swedish Antarctic expedition of 1949–52 and from recent investigations in Spitsbergen and Swedish Lapland. Newly published glaciological and climatological information, not always readily available or widely known in North America, is also ably integrated into the presentation.

Only a few of the many notable points treated can receive comment here. Among these is the fact that recent seismic soundings in the Antarctic give further support to Cailleux's suggestion that the volume of the Greenland and Antarctic ice sheets is greater than supposed heretofore. Melting of all glaciers would cause a rise in sea level, after isostatic adjustments, conservatively calculated at 60 metres (195 feet) which is notably more than the 20 to 50 metres usually given.

Ahlmann feels that Schytt's temperature and crystallographic studies in the Antarctic lend support to his earlier statement that the continental Pleistocene ice sheets were largely polar, that is at subfreezing temperatures to depths of several hundred feet. However, this interpretation may too greatly discount the influence of meltwater on thermal regimen. Schytt's results pertain to environments in which meltwater forms only in minor amounts or not at all. It seems entirely possible that considerable meltwater may have been developed in summer over large areas along the margins of the Pleistocene ice sheets. The heat given off by this water as it percolated into the firn and refroze prevented these parts of the ice sheets from being deeply chilled even though the mean annual air temperature may have been well below freezing. Thus, a wide peripheral zone of the continental ice sheets could have had a temperate thermal regimen.

Evaluation of the meteorological factors affecting ablation is discussed. In this connection it might be well to point out that some method is sorely needed for measuring ablation of snow and firn with an accuracy and reliability equivalent to that with which the meteorological factors are measured. This is not an easy task, but it is essential to an eventual balancing of the ablation equation.

A sound discussion of the lag between changes in regime and changes in behaviour of glacier snouts is offered. However, in a following section note is made of a synchronous and proportional relation between regimens and recessions of the snouts of the Kårsa and Stor glaciers in Swedish Lapland. Because of the lag factor, these relations cannot be those of direct cause and effect. Rather it seems that variation of some ablation factor or factors has had a simultaneous and corresponding effect upon total regime and upon wastage of ice at the snout. Eventually, perhaps, glaciers and the principles governing their behaviour will be well enough known so that a reasonable estimate or calculation of the lag factor for individual glaciers will be possible.

Mention is made of the fact that some glaciers seem to have a "threshold" response which causes them to undergo pulsational advances and recessions under conditions of essentially uniform nourishment. This is a matter warranting the serious attention of glaciologists and physicists because it involves the fundamental properties and behaviours of ice and the modes of flow in a glacier. Expressed in grossly oversimplified terms, the question is whether glaciers are essentially "plastic" or essentially "viscous" in their behaviour. In this connection it is well to keep in mind the possible differences of polar and temperate glaciers and also to evaluate the relative contributions to total movement provided by basal slip and by deformation within the ice body itself.

The results from the many lines of investigation bearing on recent climatic changes can be confusing unless placed in proper perspective. Dr. Ahlmann skilfully integrates and summarizes this dispersed material to support the conclusion that the so-called recent "climatic improvement" of the North Atlantic region came to an end between 1930 and 1940 with a return to conditions somewhat more favourable for glaciers. The success of Scandinavian researches in tracing the recent "climatic improvement" makes one wish that a more vigorous program of investigation might be launched on the corresponding "climatic deterioration" in the semiarid southwestern United States, another marginal area sensitive to climatic change.

Much of the data reported by Ahlmann is clearly summarized in two illuminating graphs on page 38. These are most useful for showing in relative amounts the great shrinkage of glaciers during the post-Wisconsin xerothermic period, their resurgence during the subsequent "climatic deterioration" culminating about 500 B.C. in a climate which, with fluctuations, has continued to the present day. These fluctuations caused a considerable glacial recession during the Roman period (A.D. 0–400) and also produced in many areas between 1650 and 1750 the greatest glacial advance of the post-Wisconsin period.

Dr. Ahlmann renders us all great service by bringing together in this little booklet a stimulating view of some exciting chapters in the history of recent climatic fluctuations. ROBERT P. SHARP

NORTH: THE NATURE AND DRAMA OF THE POLAR WORLD.

By KAARE RODAHL. *New York: Harper and Bros. 1953. 8½ x 5½ inches; diagrams; illustrations, and end-paper map. $3.50.*

Dr. Kaare Rodahl is known on both sides of the Atlantic for his studies of human nutrition in cold climates. A decade ago his paper on "The vitamin A content and toxicity of bear and seal liver" aroused interest because of the clues it provided to the causes of poisoning from eating polar bear liver. Later technical reports by Dr. Rodahl discussed the sources of vitamins available in plant and animal tissues in the arctic regions.

'North', while not intended as a technical report about the high latitudes, includes in chapter seven "The human factors", a useful summary discussion of human physiology, both of Whites and Eskimo, under conditions of extreme cold. The author states that he is convinced that there is a difference between Eskimo and Whites in their tolerance to cold, possibly due to differences in the anatomical structure of the skin and the blood circulation through the exposed parts. He makes it clear that Eskimo are certainly not immune to severe frostbite. In an extended discussion of other "human factors" influencing life in the far north, the author discusses the psychological effect of the arctic night. The reviewer wonders whether some of the cases of unusual behaviour quoted might not have occurred without the influence of extended darkness. Being chased by a companion with a knife during "a dispute about drink" is not unknown in less gloomy latitudes.

The author of 'North' has apparently endeavoured to make his book serve a dual purpose. Part of it deals with broad aspects of the far north, especially the Polar Basin. There are chapters on "The biology of the Polar Basin", "Ice", "Pioneers of the Polar Basin", and "Arctic resources". Here, except when the author is writing on topics which he has made his special field of study, the book has no particular contribution to make, unless it is to summarize in one place the better known material on the topics.

There is an understandable tendency to stress the contribution of Norwegian scientists and explorers, but even such cultural nationalism can be carried too far. One would expect a book on the Polar Basin to include reference to the work of the better known United Kingdom and Canadian contributors, and at least some acknowledgment of the work of Danes, if only in Greenland. There can be no objection to the appearance of a popular work on the far north, particularly from such an authority as Dr. Rodahl, and the demand for such books is a healthy sign of public interest in this vital area. It is all the more important to ensure that such books are completely accurate and the material included in them reasonably representative. On these grounds 'North' is open to some criticism. The Index does not include the name of Nares, although he and his colleagues of 1875-6 were certainly "Pioneers of the Polar Basin", and Knud Rasmussen surely deserves better than a passing reference in the form of an allegation that he founded the Thule trading station in 1910 in order to forestall Peary! The cache found in north Ellesmere Island in 1952 had been left by Godfred Hansen, not Peary. Only oversight can account for the reference to Port Radium as being on Great Slave Lake, and to mineral production of the Yukon and Northwest Territories as including "valuable harvests from arctic resources of coal, copper, silver, lead, uranium and nickel" but excluding gold. The extended reference to Greenland cryolite is not entirely accurate, and it is surely hardly correct to attribute exploration in the Point Barrow petroleum reserve as being due to "a serious oil shortage in California during 1943."

The "general" chapters of 'North', despite such minor shortcomings, are useful but they need to be read with care and discernment.

Of perhaps greater interest to the non-specialist reader are chapters reporting on the occupation of Ice Island T 3 by the United States Air Force. These form the second part of the book. Eight chapters cover the discovery of ice islands over the years, the initiation of "Project Icicle", the flight from Alaska across the Canadian Archipelago to Thule in Greenland, the flight to T 3, the landing there, and the establishment of a three-man camp preliminary to a more permanent base. The book ends with a description of the "permanent" establishment there and the type of work being carried on.

Much of the account of these events is familiar to readers of popular weeklies, since "this thing was not done in a corner", but Dr. Rodahl has provided a useful and well-written account from the viewpoint of a civilian observer. Readers unfamiliar with modern military

aerial exploration in the far north will be interested to learn of the elaboration with which such modern enterprises are carried on. At one time there were more than thirty persons "grounded" on T 3. This astonishing settlement so near the north pole was partly the result of failure of a U.S. Navy aircraft to take-off after having arrived on a trip from Alaska. The author gives the impression that at this time there was a lack of identity of interest, if not of objectives, between the U.S. Air Force and the U.S. Navy concerning title to the island. Rodahl describes how, earlier, the release of news that Navy aircraft were on their way to T 3 led the Air Force at Thule to step-up their own plans. Shortly before the speeded-up take-off, the General in charge of the base there urged his men to new endeavours with these stirring words: "If the Navy can fly over the central Polar Basin on March 19, I can see no reason why the Air Force should not be capable of doing the same thing". When faulty radar seemed likely to make a delay inevitable, he is reported as adding "Radar, or no radar . . . let's go." They went. Kaare Rodahl gives a play by play description of subsequent events until his return to Alaska some weeks later.

TREVOR LLOYD

INSTITUTE NEWS

Election of Honorary Members

At the Annual Meeting of the Board of Governors held in New York on 17 November 1953 His Excellency Professor Hans W:son Ahlmann, Swedish Ambassador in Norway, and Dr. Harald U. Sverdrup, Director of the Norsk Polarinstitutt, were elected Honorary Members of the Arctic Institute.

This brings the number of Honorary Members elected since the start of the Institute to seven.

Resignation of Mr. P. D. Baird in July 1954

At the Executive Meeting on 16 November 1953 Mr. P. D. Baird, Director of the Montreal Office, announced that he would be returning to Scotland in July of 1954. His resignation from this date was accepted with much regret, and the Institute is now looking for a worthy successor.

Copies of Vaino Tanner's work on Newfoundland-Labrador

The Montreal Office of the Institute has received from Mrs. Tanner the remaining stock of Vaino Tanner's 'Outlines of the geography, life and customs of Newfoundland-Labrador' for disposal on this continent. This two-volume work is still the major text on the area. Copies, separately-bound, of the massive bibliography are also available. The details are as follows:

OUTLINES OF THE GEOGRAPHY, LIFE AND CUSTOMS OF NEWFOUNDLAND-LABRADOR. By V. Tanner. *Acta Geographica* 8. Helsingfors: 1944.

Vol. 1	pp. 1–436 (paper cover)	
	Part I:	The land, its structure and surface forms
	Part II:	The Labrador Sea and the Labrador Current
	Part III:	The meteorology and the climate
	Part IV:	The plant life
	Part V:	The animal life
Vol. 2	pp. 437–826 + 83 pp. of bibliography (paper cover)	
	Part VI:	The human life
	Bibliography	

The two volumes together are offered at $6, separate volumes at $3. Thirty-five sets are available and thirty extra copies of Volume One.

A BIBLIOGRAPHY OF LABRADOR. By V. Tanner. Helsingfors: 1942. 83 pp. (Paper cover). Contains 1,127 items and 116 maps or charts. Offered at $1.50. One hundred and forty copies available.

NORTHERN NEWS

Notes on the fish of Banks Island

At the end of August, 1851, the crew of the *Investigator* obtained a few "trout" up to a pound in weight from a comparatively small lake near Ballast Beach on the north coast of Banks Island.[1] Apart from this record of over a hundred years ago there appears to be no mention of fish in the rather scanty literature which deals with Banks Island. The casual observations made during the Defence Research Board's 1952 and 1953 expeditions are therefore recorded below. In the first year I was assisted by Mr. Andrew Macpherson, and in the second, by Capt. I. M. Sparrow, R.E. An account of the first expedition is published in the October 1953 number of *Arctic* (Vol. 6, pp. 171–97).

The present Eskimo inhabitants of Banks Island told me that as far as they knew there were no fish[2] around the coast of the island except in the vicinity of the mouths of the Sachs and De Salis rivers. At the former place, where the Eskimo now congregate in the spring, they catch enough Arctic Char to form a useful supplement to the food of five families between about the beginning and end of July when they usually leave for the mainland, but apparently the fish are not plentiful enough to put up for winter use. In the fall, fish are sometimes caught through the ice of the first lake up the Sachs River, and also at Raddi Lake. I was told that at Raddi Lake Arctic Char, Lake Trout, and whitefish could be obtained.

[1]Armstrong, A. 1857. 'A personal narrative of the discovery of the North-West Passage.' p. 413.

[2]This was their actual expression. It must be interpreted to mean no fish of use to them as food, or not enough fish to make net-setting worth while. It is also possible that they have not tried many places, since at present they seldom go far from Sachs Harbour during the summer. They have never visited the north coast.

In 1952 we set out a 4-inch mesh net a little north of Cape Collinson during the night of July 19–20, and again north of Nelson Head from July 22 to 26, but most of this time the weather was stormy and no fish were caught. Drifting ice or bad weather at our later stops made it impracticable to fish.

In 1953 a net set on July 16 about 12 miles up the Thomsen River produced one Arctic Char the next day. Between July 18 and August 2, while we were at the northeast point of Castel Bay, we set out three 50-foot nets, one with a 2¾-inch mesh and two with a 4-inch mesh, whenever drifting ice made it practicable. About 100 Arctic Char of average size, 50 whitefish, and a number of sculpins were caught.

The dried head of one of the whitefish was brought back to Ottawa and has been tentatively identified as *Coregonus sardinella* by Mr. Vladimir Walters, Department of Biology, New York University. Mr. Walters informs me that he has found this species along the arctic coast as far east as Bathurst Inlet, and that a whitefish, not specifically identified, has been taken on King William Island; otherwise the genus has not previously been recorded from the Arctic Archipelago.

Between August 5 and 8, about 8 char were caught in the lagoon at the northwest point of Mercy Bay, but a net set on the opposite side of Mercy Bay in the shallow, muddy water inside the ice barrier at Back Point for a few days about August 15 was unproductive. After that, ice conditions did not permit further fishing.

Amongst the Arctic Char obtained at Castel Bay were two fish considerably larger (a male weighing 15 lbs., and a female weighing 14 lbs.) than the rest. These had yellowish flesh, very different from the red or pink flesh of the others. Their skin also was different, being dark

and mottled. Although their resemblance to Lake Trout occurred to me at the time, I did not then know that that species ever visited salt water (actually it was no more than brackish), and I assumed that these two fish must be merely large, old char, although I had never previously seen such yellow-fleshed, dark-skinned char in salt water. Walters,[1] however, mentions that members of the Canadian Arctic expedition noted Lake Trout in the mouths of some of the large rivers near Coronation Gulf, and that a specimen in the American Museum of Natural History was caught 5 miles off shore in Hudson Bay. In view of this I am now fairly sure that the two fish we caught at Castel Bay must have been Lake Trout. As mentioned above, the Eskimo considered that there were Lake Trout in Raddi Lake, and Walters records that the species was taken on Wollaston Peninsula, Victoria Island, by the Canadian Arctic expedition.

A specimen has also been recorded from Southampton Island, and a fish believed to be a Lake Trout was taken about three miles up the Hantzsch River, west Baffin Island.[2] T. H. Manning

Expedition to Ungava, summer 1953

Rumours of the existence of an unusual bear, akin to the Barren Ground Grizzly, are not uncommon from the northern section of Quebec. During the summer of 1953 Mr. Oshin Agathon and Mr. T. Donald Carter, Assistant Curator, Department of Mammals, American Museum of Natural History, investigated these rumours. They also secured a specimen of the Barren Ground Caribou and made collections of small mammals, birds, and freshwater life whenever time permitted. The following account is based on a report written by Mr. Oshin Agathon to Dr. Harold E. Anthony, Deputy Director, Chairman and Curator, Department of Mammals, American Museum of Natural History, who had originally planned to lead the expedition.

The most hopeful area for the search was considered to be a strip across Ungava, just to the south of the tree-line, bounded on the east coast by Fort Chimo and Leaf Bay and on the west by Great Whale River and Lake Minto. The first two weeks in August were chosen to coincide with the salmon runs and the best flying weather. The party travelled by chartered aircraft, and had hoped to make a number of reconnaissance flights from each settlement, but bad weather and other difficulties curtailed their program.

After stops at Montreal, St. Jovite, and Senneterre the party reached Rupert House, where they started their investigations. The general pattern was to question the Hudson's Bay Company's Post Manager and as many of the natives and other inhabitants as possible. A few Black Bear had been killed at Rupert House, but while there were vague reports of a brownish coloured bear, none of these could be substantiated. At Great Whale River the Indians had just killed two Polar Bear, which they had not seen for several years, and reported that they rarely took Black Bear on their trips inland, but had never seen a brown-coloured bear. At Lower Seal Lake, Fort Chimo, Indian House Lake, and Knob Lake much the same story was heard. Again, there were vague rumours of a brownish bear and Black Bear were generally very scarce. On their way back to New York a female Black Bear with two cubs was spotted from the air between Lake Nichicun and Roberval.

Mr. Agathon and Mr. Carter concluded that it was most unlikely Grizzly Bear existed in the region, though this could not be proved from one short trip; nor could they find any evidence of a light-coloured phase of Black Bear similar to the Glacier Bear of Alaska.

Mr. Agathon spent any spare time observing life in small ponds and marshy lakes. Two female toads found near

[1]Walters, Vladimir. 1953. "The fishes collected by the Canadian Arctic expedition 1913–18, with additional notes on the ichthyofauna of Western Arctic Canada." *Nat. Mus. Can. Bull.* No. 128 (*Ann. Rep. for Fisc. Yr.* 1951–52) pp. 257–74.

[2]Manning, T. H. 1942. "Notes on some fish of the Eastern Canadian Arctic." *Can. Field-Nat.* Vol. 56, pp. 128–9.

Lake Nichicun were brought back alive. Mr. Carter obtained about sixty specimens of small mammals. The caribou specimen, a fine male in late velvet, was secured by Mr. Agathon near Indian House Lake on August 12.

A great many old caribou trails were seen on the flights from Rupert House to Fort Chimo, but there were very few recent signs though caribou lichen was plentiful. From Fort Chimo south to Indian House Lake, and beyond Lake Nichicun, caribou trails appeared much fresher.

OBITUARY

W. L. G. Joerg (1885-1952)

On 7 January 1952 one of America's leading geographers, W. L. G. Joerg, Chief Archivist of the Cartographic Records Branch of the National Archives in Washington, D.C., died suddenly of cerebral hemorrhage at the age of sixty-six.

Wolfgang Louis Gottfried Joerg was born in Brooklyn, New York, on 6 February 1885. His father, a German-born physician, and his mother, born in Geneva, Switzerland, recognized the aptitude of their son, and gave him every encouragement. After graduating from Brooklyn Polytechnic Preparatory School at fourteen he searched in vain among American institutions for well-rounded courses in geography. His remarkable fluency in European languages and the classics, made possible his successful studies at Thomas Gymnasium and the University of Leipzig in Germany from 1901–4. Following a year at Columbia University, New York City, completing courses in geography and surveying, he spent five profitable, happy years at the University of Göttingen in Germany.

Fired with enthusiasm about the new science, geography, he joined the American Geographical Society in 1911, as an assistant to Cyrus C. Adams, Editor of the *Bulletin*. This association with the American Geographical Society was to last for twenty-six years, through March of 1937. His precise scholarship and editorial ability early were recognized, first as Assistant Editor of the *Bulletin*, then as Associate Editor of *The Geographical Review*, 1916–20, editor of the Society's Research Series, 1920–6, and finally as Research Editor of the Society, 1926–37. In April 1937 Mr. Joerg was appointed Chief of the newly created Division of Maps and Charts of the National Archives in Washington, D.C., a responsibility for which he was unusually well qualified.

The geography, cartography, and exploration of the polar regions had fascinated him, Mr. Joerg once mentioned, at a very early age. It was, he said "a sign of the times." His interest was spurred by the expeditions of Peary and others, and matured during his studies at Göttingen under Professor Ludwig Mecking. Although Mr. Joerg had never seen the arctic and antarctic regions, he became so well versed in the literature and in the knowledge of their geography that very many explorers and scientists working in these regions sought his advice.

Perhaps Mr. Joerg's first publication on the Arctic was his "brief statement as to the origin and scope of the Map of the Arctic Regions. . ." which appeared in the *Bulletin of the American Geographical Society* (Vol. 45 (1913) p. 610), and he was responsible for the "final version, exclusive of the soundings." In the late 1920's, when the American Geographical Society embarked on its program of polar research and publication Mr. Joerg, as Research Editor in charge, was responsible for publishing the 'Problems of polar research' and its companion volume 'The geography of the polar regions'. The editorial perfection which he achieved in preparing these and other contributions by polar experts went far towards establishing his reputation in that field. From the date of these volumes

to the time of his death, he seldom passed a year without producing or collaborating in a major article on the polar regions. Some of these contributions resulted from his appointment as chairman of the Special Committee on Antarctic Names of the United States Board on Geographic Names, 1944–7, and as a member of its successor, the Advisory Committee on Antarctic Names.

Mr. Joerg's affiliations with and recognition by scientific societies throughout the world have been numerous. In May 1944 he attended the meeting in New York City, at which plans were initiated for the founding of the Arctic Institute of North America, and in 1949 he was elected a Fellow of the Institute.

As geographers and kindred scientists read more of his published works they will respect him as one of the fathers of American geography and a specialist whose contributions to the literature of geography of the polar regions, rank not only as scholarly treatises but will remain for a long time as basic documents on the subject.[1]

HERMAN R. FRIIS

[1]The following publications summarize parts of Mr. Joerg's life and his professional contributions, of which there can only be brief mention in this biography: "Resignation of Mr. W. L. G. Joerg from the Staff", *Georg. Rev.* Vol. 27 (1937) pp. 315–7; John K. Wright, "W. L. G. Joerg", *Geogr. Rev.* Vol. 42 (1952) pp. 482–8; and John K. Wright, 'Geography in the making; The American Geographical Society, 1851–1951', New York: 1952, 437 pp. A detailed biography of Mr. Joerg and a full bibliography of his publications prepared by the writer may be found in the *Annals of the Association of American Geographers*, Vol. 43 (1953) pp. 254–83.

ELECTION OF FELLOWS

At the Annual Meeting of the Arctic Institute held in New York on 17 November 1953 the following were elected Fellows of the Institute:

Dr. W. S. Benninghoff, U.S. Geological Survey, Washington, D.C., U.S.A.

Dr. Lloyd V. Berkner, Associated Universities, New York, N.Y., U.S.A.

W. E. Brown, Hudson's Bay Company, Winnipeg, Man., Canada.

Dr. Y. O. Fortier, Geological Survey of Canada, Ottawa, Ont., Canada.

S/L. K. R. Greenaway, R.C.A.F., Ottawa, Ont., Canada.

Dr. Francis Harper, 115 Ridgway Road, Mount Holly, N.J., U.S.A.

Dr. I. Hustich, University of Helsinki, Finland.

George Jacobsen, The Tower Company, Montreal, Que., Canada.

Frederick Johnson, Peabody Foundation, Phillips Academy, Andover, Mass., U.S.A.

Dr. A. W. Jolliffe, Queen's University, Kingston, Ont., Canada.

Dr. Margaret L. Lantis, Arctic Desert Tropic Information Center, Maxwell Air Force Base, Ala., U.S.A.

Dr. F. H. Moffit, Cosmos Club, 1520 H Street N.W., Washington, D.C., U.S.A.

Dr. Troy L. Péwé, U.S. Geological Survey, Washington, D.C., U.S.A.

Dr. Froelich Rainey, University Museum, Philadelphia, Penn., U.S.A.

Dr. Robert Rausch, U.S. Public Health Service, Anchorage, Alaska.

Dr. Th. Sørensen, Kgl. Veterinær Landbohøjskole, Afdl. Systematisk Botanik, Rolighedsvej 23, Copenhagen V, Denmark.

Dr. J. C. Troelsen, Mineralogisk Museum, Østervoldgade 7, Copenhagen K, Denmark.

Paul-Emile Victor, Expéditions Polaires Françaises, 47 Ave. du Marechal Fayolle, Paris 16, France.

Dr. V. C. Wynne-Edwards, Marischal College, University of Aberdeen, Scotland.

GEOGRAPHICAL NAMES IN THE CANADIAN NORTH

The Canadian Board on Geographical Names has recently adopted the following names and changes for official use in the Northwest Territories. For convenience of reference the names are listed by the maps on which they may be found. The latitude and longitude given are approximate only and refer to the first letter of the name except where a precise location is given for a place or a spot height for a mountain.

Dubawnt Lake, 65 N.W. and 65 N.E. (8 miles to 1 inch)

(Adopted 1 May 1952)					
Big Rocky Lake		62°	17N.,	102°	22W.
Cairn Point		62	42	97	45
Ecklund Lake		62	26	103	17
Ernie Lake		63	16	102	23
Esker Point		62	34	97	37
Fitzpatrick Lake		63	57	101	47
Gravel Hill Lake		62	09	103	52
Kamilukuak River		62	35	101	50
	and	62	02	102	09
Kogtok River		62	17	97	04
Little Rocky Lake		62	21	102	17
Mary Lake		62	21	103	34
McCrae Lake		63	32	99	10
Mosquito Lake		62	36	103	27
Muskeg Lake		62	04	103	44
Oman Lake		62	14	103	19
Outlet Bay		63	29	100	55
Snow Island		63	10	101	54
Snow River		62	50	102	32
Teall Point		63	03	101	56
Weasel Point		62	26	97	26
Windy Point		62	36	98	00
(Not adopted)					
Rutley Creek					
Sunset Creek					

Fort Collinson, 87 N.W. and 87 N.E. (8 miles to 1 inch)

(Adopted 6 June 1952)					
Anderson Point	71°	38N.,	118°	12W.	
Berkeley Point	71	35	118	53	not Berkley Point
Collingwood Range	71	29	117	03	
Crag Point	71	33	118	03	
Fish Bay	71	23	117	47	
Flagstaff Hill	71	35	117	48	not Flag Staff Hill
Fort Collinson	71	37	117	57	
Holman Island (post)	70	44	117	44	
Investigator Island	70	31	116	04	
Jago Bay	71	39	118	03	
Kings Bay	70	42	117	53	
Mount Phayre	71	27	118	17	
Parkes Bluff	71	37	118	24	
Skead Bluff	71	37	118	07	
Winter Cove	71	34	117	55	
(Altered application)					
Tahiryuak Lake	70	57	112	24	
(Not adopted)					
De Salis Bay					
Kookgyak River					
Le Mesurier Islands					
Naodlan Island					
Ohmanahok (harbour)					

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